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JANUARY 1984 NUMBER 185

Monthly Report on the Nuclear Fuel Market

NUEXCO

HEADQUARTERS

Building 3, Suite 290
3000 Sand Hill Road
Menlo Park, California 94025
Telephone: (415) 854-1510
Telecopy: (415) 854-2115
Telex: 470674 (NUEXCO UI)
TWX: 910-373-1760 (NUEXCO MNPK)

J. Robert Wolcott
Chairman

George White, Jr.
President

Wayne D. Fowler
Senior Vice President

Mathias M. Klingler
Chief Financial Officer

Richard K. Andersen, V.P.

Thomas A. Boyden, V.P.

R. Wesley Miller, V.P.

Christian C. Guitton

Kim Peyton McDonald

Donald W. Radcliffe

Judith L. Sellers

EUROPE

13 chemin du Levant
01210 Ferney-Voltaire
France
Telephone: (33-50) 428035
Telecopy: (33-50) 428526
Telex: 385288 (NUEXCO F)

James E. Vaughan
Senior Vice President

Kathryn K. Bowen

W. Scott Hickman

NORTHEAST UNITED STATES

100 Prospect Street
Century Plaza South
Stamford, Connecticut 06901
Telephone: (203) 323-1999
Telecopy: (203) 325-1483
Telex: 4750124 (NUEXCO C)

Kenneth R. McCue, V.P.

Robert J. Alexander

Earl E. Hoellen, Jr.

Teresa Elms Lindsay

SOUTHEAST UNITED STATES

Suite 500
Seven Piedmont Center
Atlanta, Georgia 30305
Telephone: (404) 262-7375
Telecopy: (404) 233-6210
Telex: 4611142 (NUEX ATL)

M. Jerry Reaves, V.P.

James H. Allen

(See inside back cover for list of Representatives and Consultants)

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EXECUTIVE SUMMARY
REPORT 185
(All data as of December 31, 1983)

Exchange Value $22.00, down $0.50

The **Exchange Value** is **$22.00** per pound U_3O_8, down $0.50 since last month. Two uranium sales transactions are reported, involving approximately 0.7-1.0 million pounds U_3O_8. One transaction involved concentrates and one was for enriched UF_6.

Supply-Demand Ratio rose to 2.4:1

Active spot and near-term **uranium supply** amounts to **5.9 million** pounds U_3O_8 *equivalent,* up 200 thousand pounds from last month. Active spot and near-term **uranium demand** totals **2.5 million** pounds. The spot and near-term **supply-demand ratio** rose to **2.4:1.**

Transaction Value unchanged at $23.85

The **Transaction Value** is **$23.85** per pound U_3O_8, unchanged since last month. It includes 16 transactions involving a total of 2.3 million pounds U_3O_8 equivalent and covers a period of 6 months. No new transactions were added to the calculation.

Loan Use Charge Rate unchanged at 6%

The **Loan Use Charge Rate** remains **6 percent** per annum. Two U_3O_8 loans are reported this month, involving a total of approximately 500 thousand pounds.

Conversion Value remained at $0.60

The **Conversion Value** is **$0.60** per pound U as UF_6, unchanged since last month. One secondary market conversion transaction is reported, involving approximately 100 thousand pounds U as UF_6. Active secondary market supply of conversion services for delivery within three years totals 3.4 million pounds U as UF_6; active demand amounts to 1.3 million pounds.

SWU Values $105 for DOE-origin (FY 84) $85 for non-DOE origin (delivery within 15 months)

The **SWU Values** are **$105** per SWU of DOE origin for FY84 delivery and **$85** per SWU of non-DOE origin for delivery within 15 months. Four SWU transactions are reported this month, involving a total of 400 thousand SWUs. Active secondary market supply of enrichment services totals approximately 900 thousand SWUs; spot and near-term demand totals 600 thousand SWUs.

Enrichment

The December 30 draft of the new Utility Services enrichment contract aims to give utilities a better deal for enrichment services while curbing the trend of DOE's loss of business. Some of the important terms of the USEC are analyzed in this Report, along with the contract's probable impact on the secondary SWU market.

Canada

The Key Lake mine and mill is producing U_3O_8 on schedule, and results of drilling at Cigar Lake in northern Saskatchewan reveal an exceptionally high-grade uranium deposit.

Italy

ENEL's most recent electricity generating plan calls for a dramatic increase in the use of nuclear power by 1995.

United States

One new unit achieved commercial operation during December and two others neared that stage.

Analysis and Commentary

The Federal Energy Regulatory Commission is considering revising its nuclear fuel accounting rules, and the revisions could have widespread implications for nuclear utilities.

Basic Considerations

DOE operates three gaseous diffusion enrichment plants in the eastern US that together are capable of producing 27 million SWUs annually.

Focus: United Kingdom

Despite having the world's oldest commercial nuclear power program, the UK currently relies heavily on coal-generated electricity. Attempts to implement a PWR program in the UK are stalled pending completion of the Sizewell B inquiry.

Focus: Japan's Nuclear Infrastructure

With a healthy and well-organized industrial base, Japan is now virtually self-sufficient for nuclear hardware and systems. It is on the road to becoming self-sufficient in fuel cycle services as well.

1983 Index

This Report includes an index to reports published in 1983 (173-184).

This Executive Summary may be reproduced for internal distribution.

NUEXCO REPORT 185 FIGURES OF THE MONTH (December 31, 1983)	This Month (Report 185)	Last Month (Report 184)	12 Months Ago (Report 173)
Exchange Value[1]	22.00	22.50	20.25
Transaction Value[1]	23.85	23.85	18.80
Conversion Value[2]	0.60	0.60	1.45
Loan Use Charge Rate[3]	6%	6%	6%
Near-Term Uranium Supply[4]	5.9	5.7	8.8
Near-Term Uranium Demand[5]	2.5	3.1	3.9
Near-Term Supply-Demand Ratio	2.4	1.8	2.3
Recent Uranium Sales:			
Number of Transactions[6]	2	5	9
Quantity of material[7]	0.7-1.0	5.4-9.0	8.7-22.4
Nuexco SWU Values:[8]			
DOE origin, FY 84 delivery	105	110	
non-DOE origin, delivery within 15 months	85	90	
USDOE SWU Prices:			
AFC	138.65	138.65	138.65
Requirements	149.85	149.85	149.85
Market Value of Enriched UF_6[9] [10]:			
2.5 w/o U_{235}	603.70	653.63	693.19
3.0 w/o U_{235}	774.39	838.93	895.97
3.5 w/o U_{235}	948.22	1,027.67	1,102.91
4.0 w/o U_{235}	1,124.37	1,218.95	1,312.91

[1] US $ per pound U_3O_8 equivalent.
[2] US $ per pound U as UF_6.
[3] Per annum.
[4] Active inquiries to sell, for delivery within 12 months after contract signing (millions of pounds U_3O_8).
[5] Active inquiries to purchase, for delivery within 12 months after contract signing (millions of pounds U_3O_8).
[6] Uranium sales only; does not include loans, conversion, or SWU transactions.
[7] Millions of pounds U_3O_8, equivalent.
[8] US $ per SWU.
[9] Calculated using the Nuexco Exchange Value, Conversion Value, and 0.20 percent tails assay. Calculations before 2/28/83 used the USDOE price for AFC SWUs. From 2/28/83 through 9/30/83, calculations used the Nuexco SWU Value for the relevant fiscal year. As of 10/31/83, calculations use the SWU value for DOE origin and FY 84 delivery.
[10] US $ per KgU as UF_6.

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THE IMPORTANCE OF BY-PRODUCT URANIUM TO PHOSPHATE ROCK PRODUCERS

By

M.J. Reaves
Vice President
Nuexco

Presented To:

Industrial Minerals Conference

Phosphates: What Prospects for Growth

Orlando, Florida
December 13, 1983

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THE IMPORTANCE OF BY-PRODUCT URANIUM TO PHOSPHATE ROCK PRODUCERS

By

M.J. Reaves
Vice President, Nuexco

How important is by-product uranium to phosphate rock producers? Not very important right now, but it could be.

The Old Days

Phosphate rock in Florida and the western US averages 0.015 percent U_3O_8 with isolated concentrations as high as 0.10 percent U_3O_8. As recently as 1979, there were as many as 12 uranium recovery operations under construction, in various stages of planning, or operational in the US. Uranium prices had catapulted from the $6-8 per pound level in the early 1970s to over $43 per pound by 1979. Phosphate rock producers weren't the only ones that noticed the price rise. Companies around the world were scrambling to get into uranium exploration and production, most notably the major oil companies. Exxon, Gulf, Phillips, Sun, Texaco, Mobil, Sohio, Chevron, Conoco, Kerr-McGee, Union, Tenneco and Arco were all participants.

In January of 1980 Nuexco published a summary outlining plans for uranium recovery from phosphoric acid alone, shown here in Table 1. UNC Recovery Corporation, Wyoming Minerals and Gardinier had plants already operating in Florida. Freeport was operational in Louisiana. IMC's three plants in Florida were nearing startup and there were 3 facilities planned for Idaho by Becker Industries, Earth Sciences and Simplot. Nearly five million pounds U_3O_8 production per year was planned from phosphates.

Table 1

OPERATIONS FOR RECOVERY OF URANIUM FROM PHOSPHORIC ACID, JANUARY 1980

Company	Plant Location	Capacity (lbs. U_3O_8/yr.)	Status
UNC Recovery Corp. at W.R. Grace & Co.	Bartow, Fla.	330,000	Operational
Wyoming Mineral Corp. at Farmland Industries	Pierce, Fla.	400,000	Operational
Freeport Uranium Recovery Co.	Uncle Sam, La.	690,000	Operational
Freeport plant at Agrico Chemical Co.	Donaldsonville, La.	420,000	Start-up mid-1980
Gardinier Inc.	Tampa, Fla.	425,000	Operational
International Minerals & Chemical Corp.	New Wales, Fla.	800,000	Start-up March 1980
IMC plant at C.F. Industries, Inc.	Plant City, Fla.	600,000	Start-up by early 1981
IMC plant at C.F. Industries, Inc.	Bartow, Fla.	600,000	Start-up by early 1981
Earth Sciences, Inc. at Western Cooperative Fertilizers, Ltd.	Calgary, Alberta	120,000	Start-up early 1980
J.R. Simplot Company at Don Plant	Pocatello, Idaho	120,000	Construction begins mid-1980
Earth Sciences, Inc. at Western Cooperative Fertilizers, Ltd.	Medicine Hat, Alberta	120,000	Option to build
Becker Industries Corp. at Conda Mine area	Conda, Idaho	200,000	Pilot test planned
TOTAL CAPACITY, OPERATIONAL AND PLANNED		4,825,000	

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Prices Plunge

By mid-1982 the entire picture had changed. Uranium spot prices, as measured by the Nuexco Exchange Value, declined to a low of $17 per pound in August and September of 1982. It's pretty evident why this price drop occurred.

Actual worldwide uranium production during 1982 was 106 million pounds, most of which was produced to meet delivery obligations under contracts executed in prior years. Uranium consumption during 1982, however, was only 63 million pounds and will not approach 100 million pounds until 1987 or 1988.

We had an industry capable of making 150 milllion pounds, which was actually making 106 million pounds when only 63 million pounds were actually needed. The difference between production and consumption (some 43 million pounds) was being added to inventory, bringing total inventory to more than 400 million pounds, or equivalent to nearly 6 years forward usage. Someone, somewhere is holding that inventory with all the attendant carrying charges. Compare this with 90-day inventories of oil or 120-day coal stockpiles.

This is oversimplified, but sales of inventory competing with primary producers contributed to the price drop. The industry underwent an abrupt and violent contraction and is fundamentally different today than it was. Most of the oil companies I listed earlier are out of the business or will be soon. Only Chevron, Kerr-McGee, Tenneco and Mobil are now producing, and I have doubts about the longevity in the business of some of these companies that remain. US production in 1983 is expected to be about 19 million pounds. The typical uranium producer in the future (at least in the US) is likely to be a smaller company, producing under 1 million pounds U_3O_8 per year.

Most of the projects to recover uranium from phosphates didn't materialize either. In 1982 International Minerals and Chemical Corporation (IMC) and Freeport Uranium Recovery Corporation collectively produced and sold about 2.5 million pounds U_3O_8. This represented about 10 percent of total US uranium production.

Last fall, production also resumed at the Earth Sciences, Urangesellschaft joint venture uranium recovery plant at Calgary, Alberta. This plant is expected to produce about 100,000 pounds U_3O_8 per year. The plant utilizes phosphoric acid produced by Western Cooperative Fertilizers from phosphate rock mined in Idaho.

These companies all signed favorable long-term sales contracts with utilities when prices were high, which enabled them to survive. This is also true of most of the conventional miners of uranium in the US that survived. Almost no one in the US can produce and sell uranium at a profit for $17 per pound.

Uranium contracts based on phosphate production were considered exceptionally desirable contracts by buyers. This was true because phosphate producers could contract for 15 years or more (as long as the phosphate lasts, if they wanted to), while conventional producers were usually willing to contract only 5 to 10 years because of resource or production limitations.

Outside the US

US utilities can buy from foreign uranium producers, but not without assuming some risks. Foreign sellers may be subjected to a variety of economic, political or social circumstances that could limit or eliminate buyer interest. Canada, for instance, will allow uranium to be exported only in the upgraded form of UF_6. Many US utilities take exception to this policy because they already have long-term conversion contracts with US converters. Substantial Canadian uranium has already been sold in the US, but this policy has recently stalled new imports from Canada.

The uranium producing nations in Africa are South Africa, Namibia, Niger and Gabon. Each nation could definitely be a seller to US utilities and a limited amount of South African material has already been sold in the US. However, each nation has complex political, social and economic problems, which make them less attractive to some US buyers. American attitudes are influenced by pressure from political groups as well as by internal policies.

Australia, of course, has the world's largest known uranium resources. The two operating mines have a combined production of 11 million pounds per year. Very little of that production has been sold to US utilities. Development plans of other important deposits are currently caught up in unfavorable industry economics and the political opposition of the Labor Party. Those two problems will probably keep Australia out of the US market for at least the next five to ten years.

Future Demand for Uranium

The United States represents the largest market for intermediate and long-term unfilled requirements.

Uranium consumption, of course, is a direct function of in-place nuclear generating capacity. Uranium is a unique mineral. It has only one industrial use, which is as the principal fuel commodity for nuclear power.

Nuclear generating capacity will increase in the US

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from the installed 58 GWe in 1982 to about 111 GWe by 1992. Further growth this century almost certainly will not occur because additional plant orders are not expected before 1990. Plant lead time is presently 12 to 14 years, but this could decrease to 8 to 10 years if licensing procedures are streamlined. Expected increased uranium consumption is based solely on plants operating or under construction now, but it is still substantial.

The US had large nuclear construction programs underway prior to the "energy crisis" of the mid-1970s. These programs were cut back considerably by lack of electrical load growth due primarily to energy conservation and a sluggish economy. In the US alone, 101 plants have been canceled since 1975 (out of 251 plants ordered since 1955).

Nuclear power offers considerably greater economic advantage in Europe and the Far East than in the US. Even so, the growth of nuclear power in these areas has not been consistent. Only two countries currently have sustained nuclear programs, France and Japan. France has the most aggressive building program, presently at 24 GWe and increasing to almost 63 GWe by 1996. Nuclear capacity may comprise 60 percent of France's electric generating capacity by that time. By comparison, nuclear capacity in the US will represent only 15 percent or less of total generating capacity by 1996.

The amount of installed electric capacity in West Germany is among the largest in Europe. It was developed over the years to support Germany's large industrial base. However, the West German nuclear power program has been affected adversely by regulatory and licensing problems. The need for nuclear power was also postponed as a result of long-term development of low-grade coal resources and more recently, the availability of North Sea oil. Now, nuclear power appears to be the only remaining alternative and the German nuclear program is gradually moving forward. It is expected to more than triple from the 1982 level of 10 GWe to approximately 36 GWe by 1996.

It is generally concluded that nuclear power programs throughout the rest of Europe will continue to move forward, but on greatly diversified schedules. Spain and Italy are faced with curtailed programs due to political and plant siting problems, but both have plans to expand throughout the 1980s and 1990s. The construction program in Sweden is developing on a schedule to increase from the 1982 capacity of 6.8 GWe to 9.4 GWe in 1988.

In the Far East, Japan is totally dependent on imported energy resources. The disruption of oil deliveries in the early 1970s created new incentives for Japan to diversify its electric power base. The Japanese are converting oil-fired plants to coal and are building new coal, hydro and nuclear plants. Japanese nuclear power capacity of 17 GWe in 1982 is projected to increase to 46 GWe by 1996. Korea and Taiwan also had aggressive construction programs which were only recently curtailed for economic reasons.

Back to the US

The US utility remains the key to the recovery of the uranium industry. Other countries have been far more aggressive in obtaining long-term uranium supplies. As a result, the largest and somewhat disproportionate share of uncovered requirements are in the US. Nuexco now estimates that US utilities' *unfilled* requirements will increase annually from three million pounds in 1983 to over 30 million pounds by 1994.

Uranium spot prices are presently at $22.50 which remains well below the level required to justify most new production ventures or the reopening of shut-down properties. This is especially true in the US where the cost of production is no longer competitive with many non-US producers. US utilities may be forced to import uranium to meet their requirements.

"Where does all this put US buyers?" ". . . wishing there were more US producers to buy from," which brings me around to the point of this paper.

The long-term prospects for US uranium sellers are improving. Additional US production will be necessary and long-term contracting terms are starting to reflect this fact. A recovery in uranium prices is likely around 1985. The US uranium industry will soon be incapable of supplying unfilled US requirements without the reentry of new producers. Higher prices will be necessary. It may be time to look at uranium by-product recovery again. There is going to be a market for it.

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MONTHLY · REPORT ON THE NUCLEAR FUEL MARKET

January 1984 No. 185

R. WESLEY MILLER, *EDITOR* JAMES J. LIGHTNER, *ASSOCIATE EDITOR*

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To Our Readers

Included with this Report is a copy of a speech entitled "The Importance of By-Product Uranium to Phosphate Rock Producers," which Mr. Jerry Reaves, the director of Nuexco's brokerage operations in the Southeastern United States, delivered to the Industrial Minerals Conference in Orlando, Florida on December 13, 1984.

* * *

We at Nuexco wish you a happy and prosperous 1984.

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PRICING

NATURAL URANIUM

The **Exchange Value** as of December 31, 1983 is **$22.00** per pound U_3O_8, down $0.50 since last month. The *Current Market Data* section of this Report lists two uranium sales, involving approximately 700 thousand to 1 million pounds U_3O_8 *equivalent*. One transaction involved concentrates and one enriched product.

Active supply of uranium for spot and near-term delivery totals **5.9 million** pounds U_3O_8 as concentrates or natural UF_6. **Active demand** for spot and near-term delivery totals **2.5 million** pounds U_3O_8 or equivalent UF_6. The spot and near-term **supply-demand ratio** rose to **2.4:1.**

The **Transaction Value** as of December 31, 1983 is **$23.85** per pound U_3O_8, unchanged since last month. The current Transaction Value includes 16 transactions involving a total of 2.3 million pounds U_3O_8 or equivalent UF_6 and covers a period of 6 months.

The **Loan Use Charge Rate** as of December 31, 1983 is **6 percent** per annum, unchanged since last month. Two uranium loans are reported this month, involving a total of approximately 500 thousand pounds U_3O_8.

* * *

The Exchange Value fell $0.50 during December as sellers continued their efforts to stimulate buyer activity by lowering their offering prices. There was little near-term buying activity, a fact supported by the absence of new transactions for inclusion in the Transaction Value calculation. One substantial long-term sale of natural uranium is pending but is not included in this Report. Approximately half of the uranium actively for sale in the near term is in the form of natural UF_6, while active buyers in general have indicated a preference for concentrates.

* * *

After bottoming in the third quarter of 1982, the Nuexco Exchange Value recovered steadily for 12 months, reaching $24.00 per pound in the third quarter of 1983. In the fourth quarter, however, renewed inventory selling and slack demand led to new price erosion.

Factors of consequence in the current market include:

1. The contraction of the US uranium production sector has reduced the number of producer buyers, which were a major force in absorbing liquidated inventory in the past. The remaining US producers tend to fall into one of three categories: low-cost in-situ operations, by-product producers, and conventional miners committed to remaining in the uranium business.

2. Near-term utility demand is minimal. When specific requirements do emerge, the competition to make the sale has been spirited and marked by price cutting.

3. Large new quantities of inventory have become available as a consequence of the developing secondary market for enrichment services. De-enrichment swaps have liberated uranium which was previously thought of as "off the market" as a consequence of its being in the form of enriched product.

4. Much of the available inventory is in the form of natural UF_6 and is being forced into a market that is more interested in U_3O_8, causing price discounting in UF_6, which has influenced U_3O_8 prices.

5. A number of former US producers are holding substantial inventories left over from previous production operations. Without customers and with no plans to restart production, their inventories most likely will be liquidated in the near term.

6. Few US utilities seem concerned about contracting to fill their substantial unfilled requirements for the 1985-90 period. In general, utilities appear relaxed about the supply situation because of the available inventory and the downward pressure it continues to exert on prices.

The gap between spot prices and the prices required by producers for longer-term contracts is apparently not yet large enough to motivate early procurement strategies. However, if inventory holders continue to liquidate, spot prices may fall to a level that will initiate such "buy and hold" strategies. To the extent such activity takes place, it will exert upward pressure on prices. Whether that pressure would be enough to offset the downward pressure of excess U_3O_8 and UF_6 inventories remains to be seen.

* * *

The *Pricing* and *Recent Transactions* sections of Report 184 refer to two recently completed long-term contracts between an Australian producer and US utilities. The contracts were formally approved by the Australian government on November 9, 1983. The two contracts have been the subject of some interest since they appear to have resolved an apparent impasse between buyer and seller. On the one hand is the requirement that Australian-origin uranium not be exported at a price less than the Australian floor price (currently approximately US $35 per lb. U_3O_8). On the other hand is the reluctance of US utilities to accept any substantial financial exposure under an agreement having a price mechanism that requires the buyer to pay in excess of the market price (as represented by the Nuexco Exchange Value).

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While the details of these two contracts are confidential, it is possible, based on public information (much of it previously reported), the identity of the US utilities, and the known policies of the Australian government, to make certain informed observations.

1. Any uranium exported from Australia to fulfill deliveries under these contracts will be priced at the Australian floor price, even if the market price is lower.

2. Deliveries will not be subject to cancellation or postponement if the Australian floor price is higher than market price. However, there is almost surely considerable flexibility in establishing delivery quantities, so that the buyers can limit financial exposure during periods of low market prices.

3. It is likely that the term of these contracts is a series of two or three-year options which can be taken up sequentially.

4. The inclusion of a debit/credit scheme suggests the existence of some mechanism, based either on pounds delivered or dollars credited, that could trigger certain adjustments or options to adjust one or more of the commercial terms and conditions of the agreement.

5. The contracts could provide for the supply, under certain circumstances, of non-Australian material at market-related prices.

6. The basic price provision probably calls for the buyers to pay the higher of a market-related price or the Australian floor price. Such a market-related price probably would be subject to progressively larger discounts as the market price exceeds the Australian floor price by progressively larger margins.

While at first glance such an arrangement might not appear to make sense for either party, there are advantages to each. The seller has gained market share using marginal production. A worst case situation is delivery of a sharply reduced amount of material. Best case is two long-term contracts and substantial credibility in the US market. The utilities, with limited financial exposure, have gained the opportunity to diversify in an uncertain market and assure a long-term source of supply on particularly attractive terms, if prices do, in fact, move sharply higher in the longer term.

SECONDARY MARKET CONVERSION SERVICES

The **Conversion Value** as of December 31, 1983 is **$0.60** per pound U as UF_6, unchanged since last month. The *Current Market Data* section of this Report lists one secondary market sale of conversion services, involving approximately 100 thousand pounds U equivalent. Active secondary market supply of conversion services for delivery within three years totals 3.4 million pounds U as UF_6, while the corresponding demand figure is 1.3 million pounds. The large active supply of UF_6 in the market continues to keep downward pressure on the Conversion Value. Activity in the market has been sparse for the past several months.

SECONDARY MARKET ENRICHMENT SERVICES

The secondary market **SWU Values** as of December 31, 1983 are **$105 for DOE origin** and FY 84 delivery, and **$85 for non-DOE origin** and delivery within 15 months. The Value for DOE origin SWUs fell $5 from last month, as did the Value for non-DOE origin SWUs. The *Current Market Data* section of this Report lists four SWU transactions involving a total of approximately 400 thousand SWUs. Active secondary market supply of enrichment services totals approximately 900 thousand SWUs, and active demand amounts to approximately 600 thousand SWUs.

* * *

The SWU Values declined during December as sellers lowered offering prices in competition for the few remaining buyers for FY84 deliveries. While active demand for delivery within one year amounts to 600 thousand SWUs, little of that quantity applies to DOE FY84 SWUs. None of the four SWU transactions listed in this Report involve FY84 SWUs. Thus, downward pressure on the SWU Value probably will increase during the next 60-90 days, after which time the secondary market for DOE FY84 SWUs will virtually evaporate (due to DOE's 180-day notice requirement). During December many buyers continued to await issuance of the Utility Services enrichment contract (USEC). DOE issued a draft of the new contract on December 30.

POSSIBLE EFFECTS OF THE USEC ON THE SECONDARY SWU MARKET

The USEC is still in draft form, as are the terms and conditions for conversion from existing DOE contracts. Because many changes may be forthcoming before the final contract version is submitted to Congress (late this month), the level of uncertainty in the market remains high as this Report goes to press. It is possible, however, to project likely trends in the secondary market based on the preliminary terms and conditions.

In the short term there will continue to be *some* buyers willing to pay a substantial premium for DOE origin

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SWUs, in particular the few holders of modified Interim Sales contracts (ISCs), who will continue to fill their FY84-85 requirements. The basis of the two-tiered price structure of the secondary market will tend to erode, however. The two-tiered market developed after DOE issued the modified ISC in October, 1983. The modified ISC allows free substitution (no termination charge) of *DOE origin* secondary market SWUs for up to 40 percent of requirements in FY84 and up to 60 percent of requirements in FY85. As a result, DOE origin SWUs sold for $20 more per SWU than non-DOE origin SWUs in the fourth quarter of 1983. At present it appears that the modified ISC will no longer be available to 3.5-year Requirements contract holders unless they requested the ISC before DOE issued the draft USEC on December 30, 1983. The modified ISC is a "mini-deal" in that it gives customers attractive terms provided they intend to convert to the USEC. Existing DOE customers that want to convert to the USEC are required to do so (or notify DOE of their intention to do so) by July of this year. Without the continued presence of the modified ISC offer, the cause of the two-tiered market will not be sustained after the few existing ISC holders complete their secondary market purchases.

The USEC requires that 100 percent of the customer's requirements be taken directly from DOE at least through FY85 (except as such requirements may be reduced by existing inventories, assignments and ISCs). Therefore, the only potential large buyers of secondary market SWUs will continue to be 3.5-year Requirements holders who do not convert and who wish to terminate deliveries and pay termination charges. While US buyers in general would continue to pay some small premium for DOE origin SWUs, sellers of non-DOE origin SWUs, who led the market before the ISC was issued, should continue to dominate the market. In effect, the USEC does nothing to make DOE origin SWUs relatively more attractive, so prices in the two market sectors would tend to converge over the long term.

The price at which the secondary market would stabilize would depend on a number of factors. The 3.5-year Requirements contract holders will have three options:

1. taking SWUs under the existing Requirements contract;

2. converting to the USEC and accepting a savings of at least $149.85 - $135 = $14.85;

3. terminating and buying replacement SWUs in the secondary market.

For termination and secondary market participation (option 3) to be the most attractive choice, buyers would have to see a net savings after payment of termination charges (0.25 x $149.85 = $37.46 per SWU) that exceeded the net price savings of the USEC ($14.85). Secondary market prices would have to be *below* $149.85 - $37.46 - $14.85 = **$97.46.**

The current price level for non-DOE origin SWUs is near $85 per SWU. Few DOE origin SWU sellers, if any, will compete with non-DOE sellers at prices near that level. The conversion terms of the USEC as drafted allow AFC holders that convert to adjust their AFC commitments (and possible carrying costs) after FY86 by taking only their requirements (thus eliminating excessive commitments), decreasing further the incentive to sell at discounts competitive with non-DOE origin prices. Therefore, future secondary market SWU prices are likely to be based on competition among non-DOE sellers alone.

TERMS AND CONDITIONS OF THE DRAFT USEC

Introduction

This article presents Nuexco's analysis of the draft Utility Services enrichment contract (USEC). It is important to recognize that it is based only on a reading of the contract language. Numerous areas of inconsistency, imprecision or lack of definition remain to be resolved, either by changes in the contract language or by DOE policy rulings.

Terms of Conversion

Current DOE contract holders must convert to the USEC by July 1, 1984, if they wish to obtain the terms and conditions specified in this draft. New DOE customers must sign the USEC at least 18 months prior to the FY of first deliveries. The USEC applies to *all* current and future nuclear reactors owned by the customer for 30 years or until end-of-life of the plant(s), whichever comes first. With the current wording, the USEC draft implies that if a DOE customer holds an AFC contract and a Requirements contract, changing one contract over to the USEC will force the customer also to convert the other contract to the USEC. Beginning in FY89, the terms of the USEC will apply equally to all DOE customers that signed it. In the meaintime, the following terms of conversion will apply.

1. AFC contract holders that convert must accept *without reduction* 100 percent of the commitments through FY86 as defined in the current AFC Appendix A. For FY87 and FY88, the commitments defined in Appendix A may be reduced to match no less than 100 percent of the

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customer's actual requirements. If, prior to conversion to the USEC, Appendix A commitments in FY87 and FY88 are less than actual requirements, they may be left unchanged by the customer, *but only for the express purpose of reducing inventory*. At present, there is some feeling within the industry that DOE *might* be willing to grant some further relief on this point in the final USEC.

2. Requirements contract holders that convert must purchase 100 percent of actual requirements through FY86 from DOE, and at least 70 percent after FY86. These commitment levels may be offset in FY84-88 by termination notices, assignments and ISCs signed prior to December 30, 1983. DOE has indicated that the ISC offer to all 3.5-year Requirements contract holders is no longer available. DOE *will* honor all requests for the ISC made *before* the issuance of the draft USEC.

Pricing

SWU prices for USEC holders will conform to DOE's existing pricing policy. Prices will not exceed the fixed ceiling charge of $135 per SWU adjusted annually at a rate based upon changes in the US GNP Implicit Price Deflator (GNPIPD). The first adjustment will be made on October 1, 1985 (the ceiling will be $135 per SWU for FY84 and FY85). A new price ceiling willbe defined as of the first day of each FY by multiplying $135 by the ratio of the GNPIPD in the third quarter of each calendar year to the GNPIPD in the third quarter of calendar year 1984. On the first day of the FY the GNPIPD for the next quarter will not be a known statistic. As a result, price ceiling changes may require further adjustments at a later date.

Upon three years advance notice, DOE may adjust the ceiling (possibly raising it beyond the changes allowed by the above price protection formula). In such a case, customers could reduce contract commitments by *any amounts* without incurring termination charges.

Termination Charges

Five years after the start of the FY in which first deliveries were scheduled to occur under the USEC, if the customer has had no requirements for enrichment services, DOE may terminate the contract. In such a case contract advance payments of $500 per MWe capacity together with any accurals would be forfeited to DOE.

Customers that cancel deliveries when actual requirements for enrichment services exist or are anticipated will be assessed the greater of two charges:

1. advance payments and accruals, less payment of amounts contracted to DOE;

2. a charge equal to the price of one SWU (S) minus the price component representing the energy portion of the electric power charge (E) times the number of cancelled SWUs (C) times a multiplier (M) that is based on the notice period given by the customer.

$$\text{Termination Charge} = (S - E)(C)(M).$$

(M) is equal to 1 if the contract is terminated within one year of scheduled delivery, and it is equal to a progressively smaller fraction of 1 with each year of advance notice (0.9 if notice is between 1-2 years, 0.8 if between 2-3 years, etc.) up to 9 years notice, after which it is constant at 0.1.

As the termination charge formula is based on the number of cancelled SWUs, partial termination, as opposed to contract termination, appears as an acceptable option. Charges for complete contract termination with intent to turn to an alternate supplier could be prohibitively costly due to the minimum termination charge.

VTAO Charge

The current standard tails assay is 0.2 w/o, but the customer may elect the Variable Tails Assay Option (VTAO). DOE must be informed if the customer elects the VTAO at least 18 months in advance of the FY to which it would apply (actual tails assay may be specified at a later date). Although the VTAO is available, a graduated VTAO surcharge could effectively reduce the possible advantages of exercising the VTAO (see the following article for an analysis of the potential impact of the USEC tails specifications on future uranium consumption). The charge is equal to 0.007 times the SWU cost for each 0.01 weight-percent selected by the customer above 0.2. If the SWU price is constant at $135, the charge is $0.95 per SWU for each 0.01 w/o increase in the tails assay.

The VTAO surcharge could have a substantial influence on the breakeven secondary market SWU price for a buyer considering partial termination. It is conceivable that secondary market SWUs specifying high tails assays (upwards of 0.3 w/o) would be more economical than contracted USEC SWUs. The parameters involved in the calculation of the breakeven price would be the perceived value of feed material, the VTAO charge, and partial termination charges combined with secondary market SWU prices.

Leadtime Terms

1. 10 years or more in advance of a FY of delivery, the

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minimum commitment in effect in the contract may be reduced at no charge by up to 10 percent, down to a minimum of 70 percent of requirements.

2. At least 18 months prior to the FY of first delivery, the customer must advance payment of $500 per MWe of rated or anticipated capacity. There is no indication that the advance payment is prorated with the portion of requirements covered by the contract if that portion is less than 100 percent.

3. At least 18 months in advance of each FY of delivery the customer must provide updated specifications of monthly quantities and assays of required product for a subject FY. Additionally, it must indicate preferred dates for delivery of feed to DOE and inform DOE if it will elect the VTAO. Also, the customer must give DOE its estimated SWU requirements for the subsequent 10-year period, along with an update of plant operating schedules, fuel cycle data, enriched inventories, and inventory destinations if product was purchased under the USEC (Attachment 1 to Appendix A).

4. At least 180 days prior to anticipated delivery, the customer must firm up the specific quantities and assays of enriched product to be delivered and finalize delivery dates. If the VTAO has been elected, the customer then specifies the desired transaction tails assay between 0.2 and 0.3 w/o.

5. No more than 10 days after receipt of the customer's firmed up requirements, DOE will advise the customer if it disagrees with the reasonableness of the customer's specifications. No more than 15 days after such receipt, DOE may advise the customer of new delivery dates (in the case that total scheduled deliveries exceed DOE's capacity).

6. As in all DOE contracts, the customer must deliver feed in proportions specified by DOE at least 90 days prior to the beginning of an agreed delivery month. However, in a significant reversal of previous practice, DOE has inserted in the USEC draft a provision which limits and perhaps even eliminates the customer's freedom to supply material pre-enriched by other than DOE.

7. On the actual product delivery date or the delivery date requested by the customer, whichever is later, DOE may invoice the customer for all amounts due for services provided. Within 30 days of the invoice date but no later than the last day of the FY, the customer must pay all amounts due or late payment charges will be assessed.

8. Upon "reasonable" notice, DOE may terminate the contract at no cost if commercial enrichment services become available in the USA.

IMPACT OF THE DRAFT USEC ON URANIUM CONSUMPTION

Introduction

During the past few months, the USEC has been presented by some as an opportunity to develop a powerful tool to increase uranium consumption and help pull the US uranium producer sector out of its current slump. One contract mechanism considered for increasing consumption was to allow utilities to select individually the optimum tails assay for their enrichment services. Preliminary analyses showed that allowing utilities to select optimum tails assays for their enrichment contracts could have had the effect of increasing U_3O_8 consumption in the United States by as much as 50 million pounds over the next ten years, doubling the unfilled requirements for US utilities over this period.

With the draft of the USEC available for comment, it has become apparent that those hopes were misplaced. The contract's fine print has taken away the potential gains in uranium consumption and replaced them with potential losses. To evaluate the impact of the USEC on uranium consumption it is necessary to address separately the three changes to the contract which contribute to changes in uranium demand:

1. the Variable Tails Assay Option (VTAO);
2. the flexibility terms which allow customers to adjust their enrichment services to meet their actual requirements;
3. flexibility to obtain enrichment services from other sources.

Effect of Optimum Tails Assay

The cost of enriched uranium is the sum of the feed and enrichment costs, and the optimum tails assay is that tails assay for which the total cost is minimal. Without VTAO charges and with current uranium and SWU prices, a utility can save more than $1 million per reload batch by increasing its enrichment tails assay from 0.2 weight-percent (w/o) to 0.3 w/o. Not only does this change in tails assay reduce the ultimate cost of electricity to consumers, it also increases uranium consumption by approximately 20 percent. (For more background on separative work units and the optimum tails assay see Report 184, pages 17-19.)

The draft USEC contains a VTAO provision but also levies a surcharge for tails greater than 0.2 w/o (see page 4 of this Report). Adding the surcharge, a customer that specifies a tails assay of 0.3 w/o would have an effective

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SWU base price of $144.45, seven percent higher than the $135 base price referred to in the contract. The VTAO surcharge has the effect of reducing the optimum tails assay and reducing the consumption of uranium.

In defense of DOE, higher tails assays reduce the number of required SWUs, and the apparent intent of the surcharge is to cover the fixed costs associated with SWUs not delivered when the VTAO is selected. The proposed surcharge is plotted in Figure 1 as a percentage of the price for the SWUs not delivered. While it varies somewhat with enrichment and tails levels, the surcharge is approximately 30 percent of the price of the SWUs that are not delivered as a result of exercising the VTAO.

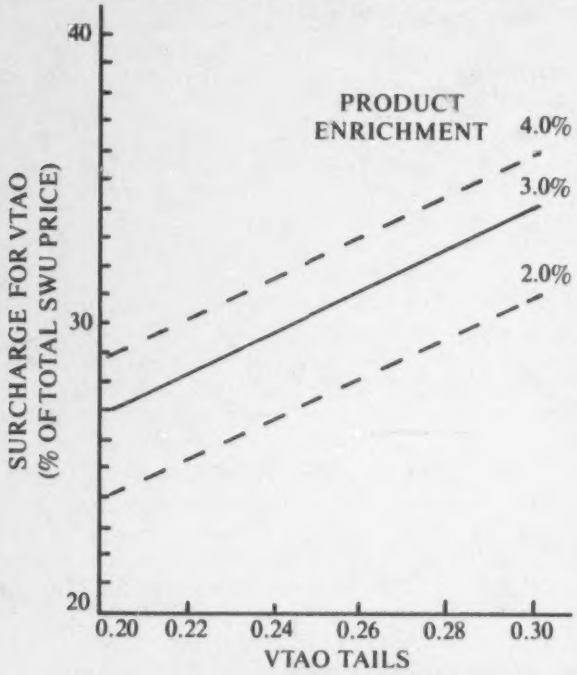

Figure 1
VTAO SURCHARGE IN TERMS OF THE PRICE OF SWUs NOT TAKEN

The effect of the proposed surcharge is complex to evaluate, and is a weak function of the product enrichment level. The impact is most readily understood and approximated by assuming that the surcharge is indeed 30 percent of the price of the SWUs that are not delivered as a result of exercising the VTAO. A good approximation of the optimum tails assay with the surcharge can then be found from previous studies (such as Figure 4 in Report 184, page 19) by replacing the *unit cost of SWUs* with *70 percent of the unit cost of SWUs*. Conceptually, the optimum tails assay curves are being used with the *variable cost* of SWUs as input, rather than the total cost.

Assuming a SWU price of $135, a conversion cost of $3.00 per pound of uranium, and a product enrichment of 3.0 w/o, Table 1 shows the effect of the surcharge on the optimum tails assay as a function of the price of uranium. The results of the approximate evaluation method are also shown to give an indication of its accuracy.

The net impact of the proposed VTAO surcharge is to reduce the optimum tails assay by about 0.04 w/o, thus reducing the uranium demand by about 7 percent. For uranium costs near or above $50 per pound U_3O_8, the optimum tails assay based on the variable cost of SWUs is less than 0.2 w/o, but DOE does not offer a credit for the extra SWUs delivered, keeping the practical optimum at 0.2 w/o.

In evaluating the impact of the USEC's VTAO terms on domestic uranium consumption, it is important to understand the current situation. In the USA, approximately 45 percent of the SWUs to be delivered to US customers are under the AFC type of contract, while the remainder are under two types of Requirements contracts. The AFC contract holders are allowed to vary tails from 0.16 w/o to 0.3 w/o at no charge, and these customers have indicated that they plan to use the VTAO, with a weighted average of 0.28 w/o tails, for about 80 percent of their enrichment services over the next decade. The Requirements contract holders are currently restricted to 0.2 w/o tails from DOE, but a number of these customers are canceling their DOE deliveries and buying SWUs in the secondary market, some of them at higher tails assays. Neglecting this last effect, the weighted average tails assay for US customers is about 0.23 w/o.

The impact of the USEC's VTAO terms depends on DOE's success in converting the current contract holders, and on the relative cost of uranium and enrichment. However, it is possible to evaluate some bounding assumptions and the relative impact of the VTAO surcharge.

1. If all US utilities used 0.3 w/o assays, uranium consumption would increase by about 14 percent, or 50 million pounds U_3O_8 over the next ten years.

2. The impact of the proposed VTAO surcharge would be to reduce the optimum tails assay by 0.04 w/o and thus reduce uranium consumption by about 7 percent, compared to a VTAO without the surcharge. If all domestic AFC holders converted to the USEC, the expected average tails assay would be about 0.24 w/o (the current average

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Table 1

EFFECT OF VTAO SURCHARGE ON OPTIMUM TAILS ASSAY

U_3O_8 Cost ($ per lb.)	Optimum Tails without Surcharge (w/o U_{235})	Optimum Tails with Surcharge (exact w/o U_{235})	Optimum Tails with Surcharge (approx. w/o U_{235})
20	0.32	0.28	0.28
25	0.30	0.26	0.26
30	0.28	0.24	0.24
35	0.26	0.23	0.22
40	0.25	0.21	0.21
45	0.24	0.20	0.20
50	0.23	0.20	0.20

of 0.28 w/o less the reduction of 0.04 w/o due to the surcharge). Thus, the best the industry could hope for would be an overall consumption increase of 1-2 percent.

3. The customers most likely to convert to the USEC are the AFC contract holders, which currently have the VTAO without the surcharge. The effect of the surcharge will be to reduce uranium consumption from this class of customer.

Effect of Delivery Flexibility

Another potential impact of the USEC on uranium consumption will be the new delivery flexibility terms for customers who convert from AFC contracts. The AFC contract holders are currently committed to take a fixed quantity of SWUs from DOE through FY88, regardless of their actual requirements. While some of these customers have been able to adjust their deliveries to meet their expected requirements, others are required to take excessive SWUs (and deliver excessive feed to DOE) to meet their fixed commitments.

The conversion terms from the AFC contract to the USEC do not provide any relief from AFC commitments through at least FY86. In FY87 and FY88, the terms apparently allow customers to reduce their commitments if the committed amount *for that year* is greater than the actual plant requirements, but do not allow them to use their accumulated excess inventory until FY89. The net anticipated impact of the new flexibility terms should be a slight reduction in FY87 and FY88 demand. For FY89 and beyond, there will be some further reduction in demand, as the USEC's flexibility terms provide a more efficient method for consuming excess inventories of enriched material. Requirements contract customers have never been forced to take excessive SWUs, so their uranium demand should not change with the new flexibility terms.

Effect of Supply Flexibility

The USEC will ultimately allow customers to take up to 30 percent of their requirements from other sources than DOE, including non-DOE primary enrichment facilities and non-DOE SWUs from the secondary market. US producers are concerned that this flexibility will facilitate the import of foreign uranium, as the non-DOE SWUs may be purchased in the form of enriched product derived from non-domestic feed material. This effect is difficult to evaluate, as it is dependent on the relative future prices of both SWUs and uranium worldwide. Currently, domestic customers are meeting about 12 percent of their requirements with non-DOE SWUs. Many of these transactions are in the form of de-enrichment swaps, where enriched material of foreign origin is exchanged for feed material from the US utility, with no net import or export of uranium.

Summary

In summary, the draft USEC offers at best a 1-2 percent increase in uranium consumption from the VTAO terms, with a probable slight loss in consumption if only the AFC contract holders convert. This percentage contrasts with a potential increase of 14 percent were tails assay specifications more flexible. There are also expected losses in the demand for US origin uranium from the delivery and supply flexibility terms of the USEC.

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CURRENT MARKET DATA

EXCHANGE VALUE $22.00/lb. U_3O_8
Determined as of December 31, 1983

Definition[1]

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

[1]In December, 1981, Nuexco published a history of the Exchange Value which chronicled, month-by-month, changes in its definition, usage and derivation. Copies are available upon request.

TRANSACTION VALUE[2]
Determined as of December 31, 1983

$/lb. U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
23.85	2.3	16	6

Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

Comments

Nuexco does not consider the following in determining the Transaction Value:

A. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.
B. The price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of Exchange Value or any other independent variable. Also excluded from consideration are all data where the delivery price is defined in such a way that it cannot currently be determined.

[2]Transaction Values for 1976 through 1981 and their associated parameters (millions of pounds, number of transactions and number of months) are tabulated on pages 31 and 32 of Report 161. Corresponding data for 1982 are tabulated on page 5 of Report 173.

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CURRENT MARKET DATA

LOAN USE CHARGE RATE[1] 6%
Determined as of December 31, 1983

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

[1]Monthly data for 1968 through 1981 appear on pages 32-34 of Report 162. Monthly data for 1982 appear on page 2 of Report 173.

CONVERSION VALUE[2] $0.60/lb. U as UF_6
Determined as of December 31, 1983

Definition

The Conversion Value is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the last day of the month.

Derivation

Nuexco bases the Conversion Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Conversion Value:

A. The price of conversion services delivered or to be delivered under old contracts.
B. The price of conversion services delivered in connection with contract renegotiations or other than arm's length transactions.
C. Transportation charges other than those customarily provided by primary suppliers of conversion services.

[2]Monthly data for 1981 and 1982 are tabulated on page 6 of Report 173.

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CURRENT MARKET DATA

SWU VALUES

$105/SWU FOR DOE ORIGIN AND FY84 DELIVERY
$85/SWU FOR NON-DOE ORIGIN AND DELIVERY WITHIN 15 MONTHS
Determined as of December 31, 1983

Definition

The SWU (Separative Work Unit) Values represent Nuexco's judgment of the prices, expressed in US dollars per SWU, at which transactions for the sale of significant quantities of SWUs of stated origins could be concluded as of the last day of the month.

Derivation

Nuexco bases the SWU Values upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.
E. SWU prices at varying tails and varying product assays are converted to the equivalent SWU price at the DOE Reference Transaction Tails Assay (presently 0.20 weight percent U_{235}) and a product assay of three percent U_{235} assuming feed costs calculated using the Nuexco Exchange Value and Nuexco Conversion Value determined as of the last day of the same month.

Comments

Nuexco does not consider the following in determining the SWU Values:

A. The price of SWUs delivered under long-term contracts from primary suppliers, such as DOE, Urenco, or Eurodif.
B. The price of SWUs delivered under other than arm's length transactions.

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EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
Australia (dollar)	24.50	54.01	63.69
Belgium (comm. franc)	1,226	2,702	3,186
Canada (dollar)	27.38	60.37	71.19
Finland (markka)	128.21	282.64	333.30
France (franc)	183.49	404.52	477.02
FRG (mark)	59.96	132.19	155.89
Italy (lira)	36,545	80,568	95,008
Japan (yen)	5,106	11,256	13,273
Netherlands (guilder)	67.46	148.73	175.39
South Africa (rand)	26.80	59.08	69.67
Spain (peseta)	3,466	7,642	9,011
Sweden (krona)	176.14	388.32	457.93
Switzerland (franc)	47.98	105.78	124.74
UK (pound)	15.19	33.50	39.50
US (dollar)	22.00	48.50	57.20

TRANSACTION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates	per kg. U_3O_8 in Concentrates	per kg U in Concentrates
Australia (dollar)	26.56	58.55	69.05
Belgium (comm. franc)	1,329	2,929	3,454
Canada (dollar)	29.69	65.45	77.18
Finland (markka)	138.99	306.41	361.33
France (franc)	198.92	438.53	517.14
FRG (mark)	65.00	143.31	169.00
Italy (lira)	39,618	87,343	102,998
Japan (yen)	5,535	12,202	14,390
Netherlands (guilder)	73.14	161.24	190.14
South Africa (rand)	29.05	64.04	75.52
Spain (peseta)	3,758	8,284	9,769
Sweden (krona)	190.95	420.98	496.43
Switzerland (franc)	52.02	114.68	135.23
UK (pound)	16.47	36.31	42.82
US (dollar)	23.85	52.58	62.00

[1]Calculated using currency exchange rates published in the Wall Street Journal on December 30, 1983.

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CURRENT MARKET DATA

CONVERSION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U as UF_6	per kg U as UF_6
Australia (dollar)	0.67	1.47
Belgium (comm. franc)	33.43	73.69
Canada (dollar)	0.75	1.65
Finland (markka)	3.50	7.71
France (franc)	5.00	11.03
FRG (mark)	1.64	3.61
Italy (lira)	996.68	2,197
Japan (yen)	139.24	306.98
Netherlands (guilder)	1.84	4.06
South Africa (rand)	0.73	1.61
Spain (peseta)	94.53	208.41
Sweden (krona)	4.80	10.59
Switzerland (franc)	1.31	2.89
UK (pound)	0.41	0.91
US (dollar)	0.60	1.32

SWU VALUES EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	DOE SWU FY84	Non-DOE SWU delivery w/in 15 mo.
Australia (dollar)	116.93	94.65
Belgium (comm. franc)	5,850	4,735
Canada (dollar)	130.69	105.80
Finland (markka)	611.89	495.34
France (franc)	875.73	708.92
FRG (mark)	286.18	231.67
Italy (lira)	174,419	141,196
Japan (yen)	24,368	19,726
Netherlands (guilder)	321.99	260.66
South Africa (rand)	127.89	103.53
Spain (peseta)	16,543	13,392
Sweden (krona)	840.67	680.54
Switzerland (franc)	229.01	185.39
UK (pound)	72.51	58.70
US (dollar)	105.00	85.00

[1]Calculated using currency exchange rates published in the Wall Street Journal on December 30, 1983.

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RECENT TRANSACTIONS[1]

Uranium Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current E.V.	Seller	Buyer	Remarks
2619	1985	301-600	109	European Entity	European Utility	Assumes $95 per SWU and $0.60 per lb. U for conversion.
2620	1984	301-600	indeterminate	unknown	US Utility	Price related to market.

Loan Transactions

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current L.U.C.R.	Lender	Borrower	Remarks
2607	1983	50-100	108	US Utility	US Producer	
2624	1984	301-600	92	US Utility	US Producer	

Secondary Market Conversion Services

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U equivalent)	Approximate Price as Percent of Current C.V.	Seller	Buyer	Remarks
2617	1984	50-100	154	US Utility	European Utility	

Secondary Market Enrichment Services

Nuexco Transaction Number	Delivery Period[2]	Approximate Quantity (thousands of SWUs)	Approximate Price[3] as Percent of Current SWU Value[4]	Tails Assay (Percent U_{235})	Seller Group	Buyer Group	SWU Origin	Remarks
2597	1985	50-100	106	to be determined	European Entity	European Utility	Eurodif	
2634	1989	50-100	113	to be determined	European Utility	European Utility	Eurodif	
2635	1985	less than 50	indeterminate	to be determined	US Utility	European Utility	DOE	FY85 AFC price less a discount.
2636	1986	101-300	106	.2	European Entity	US Utility	Eurodif	Swap for U_3O_8 instead of UF_6.

[1]Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.
[2]Refers to calendar year, not fiscal year.
[3]Price is not normalized to 0.20% tails assay.
[4]Refers to SWU Value for same origin as SWUs included in transaction.

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CURRENT MARKET DATA

URANIUM SUPPLY
(As of 12/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
1575	—	500 per year	1985-92
1818	—	500 per year	1984-90
2038	2,000	—	UF_6
2134	—	250 per year	1984-87
2201	300	—	
2203	1,000	—	
2220	150	—	UF_6
2235	—	150 per year	1985-89
2236	—	200 per year	1985-89
2263	—	500 per year	1985-90
2274	—	600 per year	1985-91
2275 A	110	—	
2297	60	200 per year	1985-89
2307	340	—	UF_6
2315	170	950	UF_6
2335	200	—	
2336	250	250 per year	1985 on
2365	20	—	
2366	600	—	
2376	200	—	U_3O_8 or UF_6
2429	450	—	
TOTAL:	5,930		
INACTIVE			
2017	1,100	1,200	
2271	—	500 per year	1984-85
2191	125	—	UF_6
2193	—	800 per year	1986-90
2309	950	—	
TOTAL:	2,175		

[1]Measured from the date of this Report.
[2]For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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URANIUM DEMAND
(As of 12/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
1459	—	200 per year	1988 on
2025	420	350	
2167	250	250 per year	1984-89
2233	700	—	U_3O_8 or UF_6
2304	—	500 per year	1987 on
2310	800	—	enriched UF_6
2313	260	255	1985
2329	—	500	1985
2372	—	250 per year	1985-88
2413	—	250 per year	1986-88
2416	—	430	
2419	50	—	
TOTAL:	2,480		
INACTIVE			
1999	—	50 per year	1985-90
2118 A	250	—	
2244	—	350 per year	1985 on
2302	—	250 per year	1987 on
2360	270	—	enriched UF_6
2371	—	260 per year	1984-90 UF_6
2414	—	100 per year	1987-91 U_3O_8 or UF_6
TOTAL:	520		

[1]Measured from the date of this Report.
[2]For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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CURRENT MARKET DATA

LOAN SUPPLY AND DEMAND
(As of 12/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Within 1 Year	Beyond 1 Year	Remarks
Available for Loan:			
ACTIVE			
1815	1,000	—	UF_6
1938	1,500	—	UF_6
2128	1,000	—	
TOTAL:	3,500		
INACTIVE			
1884	600	—	
2036	500	—	UF_6
2139	2,000	—	
TOTAL:	3,100		
Inquiries to Borrow:			
INACTIVE			
2118	250	—	U_3O_8 or UF_6
TOTAL:	250		

[1]Measured from the date of this Report.
[2]Available within one year.

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CONVERSION SUPPLY
(As of 12/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF6) Within 3 Years	Beyond 3 Years	Remarks
ACTIVE			
2051	1,500	—	
2141	1,500	—	
2143	200	—	
2220	210	—	
TOTAL:	3,410		
INACTIVE			
1609	1,500	—	
1936	1,500	—	
2181	1,300	650 per year	1985-90
2230	300	—	
2401	600	—	
TOTAL:	5,200		

CONVERSION DEMAND
(As of 12/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF6) Within 3 Years	Beyond 3 Years	Remarks
ACTIVE			
2380	700	—	
2386	330	—	
2420	300	—	
TOTAL:	1,330		
INACTIVE			
2194	—	300 per year	1986 on
2287	—	250 per year	1986 on
2295	200	—	
TOTAL:	200		

[1] Measured from the date of this Report.

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CURRENT MARKET DATA

SWU SUPPLY AND DEMAND
(As of 12/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-Term[3]	Remarks
Available for Sale:			
ACTIVE			
1859	—	1,000	
2100	—	100	
2164	120	—	
2189	85	80	1985
2192	—	325	
2210	—	70	1985
2285	500	3,000	
2345	—	500	1985
2351	—	150 per year	1985-91
2359	180	—	
2378	—	120 per year	1985-89
2408	—	120	1985
2428	—	200	1985
TOTAL:	885		
INACTIVE			
2137	80	80 per year	1985 on
2337	250	250	
2375	200	—	
TOTAL:	530		
Inquiries to Purchase:			
ACTIVE			
2233	250	—	
2310	200	—	
2346	—	100 per year	1985-89
2355	—	180 per year	1986,88,90,92
2362	150	—	
2400	—	85	1985
2410	20	85	1985
2412	—	80	1985
TOTAL:	620		
INACTIVE			
2237	—	250 per year	1985 on
2418	—	100	1987

[1]Measured from the date of this Report.
[2]For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.
[3]For delivery beyond one year.

CANADA

On October 20, 1983 the first drum of yellowcake was packaged at the Key Lake mill and by the end of November, 700 thousand pounds U_3O_8 had been produced. According to a Saskatchewan Mining Development Co. (SMDC) news release, the design capacity of 1 million pounds U_3O_8 per month from Key Lake should be reached early this year.

* * *

SERU Nucleaire (Canada) released information about a major new discovery located in the Athabasca Basin region of Northeastern Saskatchewan. The area is referred to as the Waterbury uranium deposit or Cigar Lake. During 1983, 65 holes were drilled on the primary structure. All the holes reportedly intersected the orebody, and results from some of the more remarkable holes reported are shown in Table 2.

Table 2

WATERBURY DEPOSIT DRILLING RESULTS

Hole length (meters)	Average Grade (percent U_3O_8)
3.25	10.78
6.50	19.11
9.50	25.02
13.00	11.44
14.16	7.20
15.00	13.53
17.00	24.08

The Waterbury joint venture group consists of SERU Nucleaire (33.61 percent), SMDC (50.75 percent), Idemitsu Uranium Exploration Canada (11.88 percent), and Reserve Oil and Minerals (2.75 percent). SERU Nucleaire is the operator. Announced reserves are 125 million pounds, and average grade is rumored to be 5 percent or better. Commercial development of the deposit probably will commence early in the 1990s.

* * *

At its convention in early December, the Saskatchewan New Democratic Party (NDP) voted in favor of phasing out uranium mining in the province. Ironically, the NDP once championed the expansion of the uranium industry in Saskatchewan. (It was the ruling party when SMDC was formed in part to develop uranium deposits such as Key Lake.) The NDP vote has not caused much alarm in Canadian mining circles, as the party is not likely to regain power in the near future.

ITALY

In November ENEL (Ente Nationale Per L'Energia Electrica), Italy's state utility, announced an electricity program to 1995 that includes substantial increases in nuclear power development. The plan calls for oil-fired plants' share of electricity generation to decrease from the present 50 percent to 20 percent, while coal generation will grow from 13 to 31 percent and the nuclear share will rise from 3 to 20 percent, as shown in Table 3.

Table 3

ENEL ELECTRICITY SOURCE PLAN TO 1995

Source	1983 Share	1995 Share
Oil	50	20
Coal	13	31
Nuclear	3	20
Other	34	29

Currently Italy has only three operational reactors, having a cumulative net generating capacity of 1,237 MWe. The ENEL plan shows a growth in nuclear generating capacity to almost 12,000 MWe. The two Montalto units currently under construction, which should be completed near the end of the decade, will add approximately 2,000 MWe to the total. The other 9,000 MWe of nuclear orders is in the planning stage. ENEL has faced difficulty in the past getting approval of reactor sites. Government iniatives over the past year aimed at providing incentives to regions that accept reactor sites have given rise to some optimism that plant approval will be streamlined.

UNITED STATES

During the past month three utilities announced that new units had reached or were close to commercial operation. South Carolina Electric and Gas announced on January 1 that Summer 1, its first unit, had achieved commercial operation. Pacific Gas and Electric completed fuel loading at Diablo Canyon 1 and hopes to have the unit operating commercially by May. Washington Public Power Supply Service received a fuel loading and low power testing license for WNP 2 (a BWR), which it hopes will be operating commercially by July of this year.

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ANALYSIS & COMMENTARY

THE US FEDERAL ENERGY REGULATORY COMMISSION (PART 2)

Introduction

This is the second in a series of articles examining facets of the regulatory environment in which nuclear utilities operate. Report 182 (October 1983) discusses the organization of the US Federal Energy Regulatory Commission (FERC), which is the most prominent federal regulatory body having jurisdiction over electric utilities. FERC's regulatory power actually manifests itself much more by influence than by direct regulation. The Commission's jurisdiction is limited principally to wholesale electric power transactions, defined as sales for resale. Thus, sales of electricity from an electric utility to another or to a municipality or rural cooperative fall under FERC jurisdiction. It also includes all wheeling transactions. FERC reports that all transactions under its jurisdiction account for only 5 percent of US electric utility transactions. All the rest come under state and local jurisdiction. FERC's influence comes from its working relationship with most of the state and local public utility commissions (PUCs). PUCs tend to follow FERC's lead in matters of regulation, so a FERC ruling affects much more than the 5 percent of transactions under its direct regulation.

Accounting Standards

FERC has established and enforces a Uniform System of Accounts, which contains accounting rules and procedures for the electric utility industry. Utilities must use this accounting system for all wholesale transactions. PUCs frequently use the uniform system in establishing their own accounting rules, just as many states use the federal Uniform Commercial Code in establishing their own state commercial codes. Investor-owned utilities must use FERC's Uniform System of Accounts in all stockholder reporting. As noted in Report 182, the Uniform Sysem of Accounts specifies the rules and procedures used for accounting for nuclear fuel, including related fuel cycle services.

Proposed Rule Change

Currently FERC is revising the guidelines for the accounts concerned with expenditures at the front end of the nuclear fuel cycle. A proposed rule, which is in the process of refinement, would distinguish between expenditures that are eligible and ineligible for allowances for funds used during construction (AFUDC).

AFUDC is the accounting procedure used to capitalize net composite interest and equity costs of capital funds used to finance construction (construction work in progress, or CWIP). In the same manner as construction, labor and materials costs, AFUDC is a non-cash, non-operating item and is recognized as a cost of "Electric Plant" with offsetting credits to "Other Income" and "Interest Deductions." AFUDC permits a utility to recover some capital costs through inclusion in the rate base and in the provisions for depreciation. Under current rules nuclear fuel (including U_3O_8, UF_6, enriched UF_6 and fabricated assemblies) prior to reactor loading can be included in CWIP and is therefore eligible for AFUDC.

FERC's proposed rule change affects a number of items, including:

1. advances made to DOE for enrichment services long before processing of materials is undertaken;
2. advance payments for future yellowcake deliveries that are based on estimates of requirements which proved wrong; (Payments to be addressed may include acquisition of ownership interest in mine and processing facilities, as well as advance payments under supply contracts.)
3. stockpiled nuclear materials obtained in advance of need for use in fabricating fuel assemblies;
4. disposition of gains or losses from the sale of nuclear fuel included in stock accounts.

The thrust of the proposed rule is to limit utilities from taking AFUDCs on "abnormally large inventories" of nuclear fuel that have accumulated as a result of reactor deferrals, cancellations, and other factors. The key to FERC's proposal will be the definition of abnormally large inventories and the distinction between nuclear fuel that is in the process of refinement and that which is just sitting in inventory.

Any new rules made by FERC will only be directly applicable to transactions over which FERC has authority. However, because FERC's influence is widespread, local PUCs are following the development of this rule closely. The proposed rule is scheduled to be released during the first quarter of this year.

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US DOE GASEOUS DIFFUSION PLANTS

Introduction

The US Department of Energy (DOE) operates three gaseous diffusion plants (GDPs) for the enrichment of uranium used in commercial nuclear reactors. The Oak Ridge GDP in Oak Ridge, Tennessee, was completed by the US Army Corps of Engineers in 1945 as part of the US government's Manhattan Project (Figure 2). The original Oak Ridge facility contained a complete cascade, meaning that the plant was capable of enriching feed for military purposes to greater than 97 weight percent (w/o) U_{235}. The Paducah GDP in Paducah, Kentucky was constructed over a four-year period ending in 1954, and the Portsmouth GDP in Portsmouth, Ohio was completed in 1955.

Overview of Facilities

Gaseous diffusion enrichment is accomplished by passing UF_6 feed through a series of stages that gradually separate enriched UF_6 from depleted UF_6 (see Report 184 for a survey of the enrichment process). Each stage contains a diffuser vessel, a gas compressor for the feed line, a drive motor, a control valve and associated piping. A heat exchanger controls the stage temperature. The diffuser vessel contains the porous tube barrier through which enriched product is drawn; the separation efficiency of each stage is a function of the size of the holes in the barrier. Eight to ten stages comprise a cell (Figures 3 and 4), and at DOE's facilities UF_6 feed is passed through a number of interconnected cells located in several process buildings.

Two types of compressors, axial flow and centrifugal compressors, are required to compress UF_6 gas to the pressures necessary to cause flow through the barriers and between stages. The large electric motors which drive the gas compressors are rated at 3300 horsepower each. To indicate the scale of these large stage components, a single SWU involves circulation through a single stage of over 640 thousand kgs of UF_6.[1]

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[1] "United States Gaseous Diffusion Program for Uranium Enrichment", UCC-ND 1982. US Government Printing Office: 1982-546-067/32.

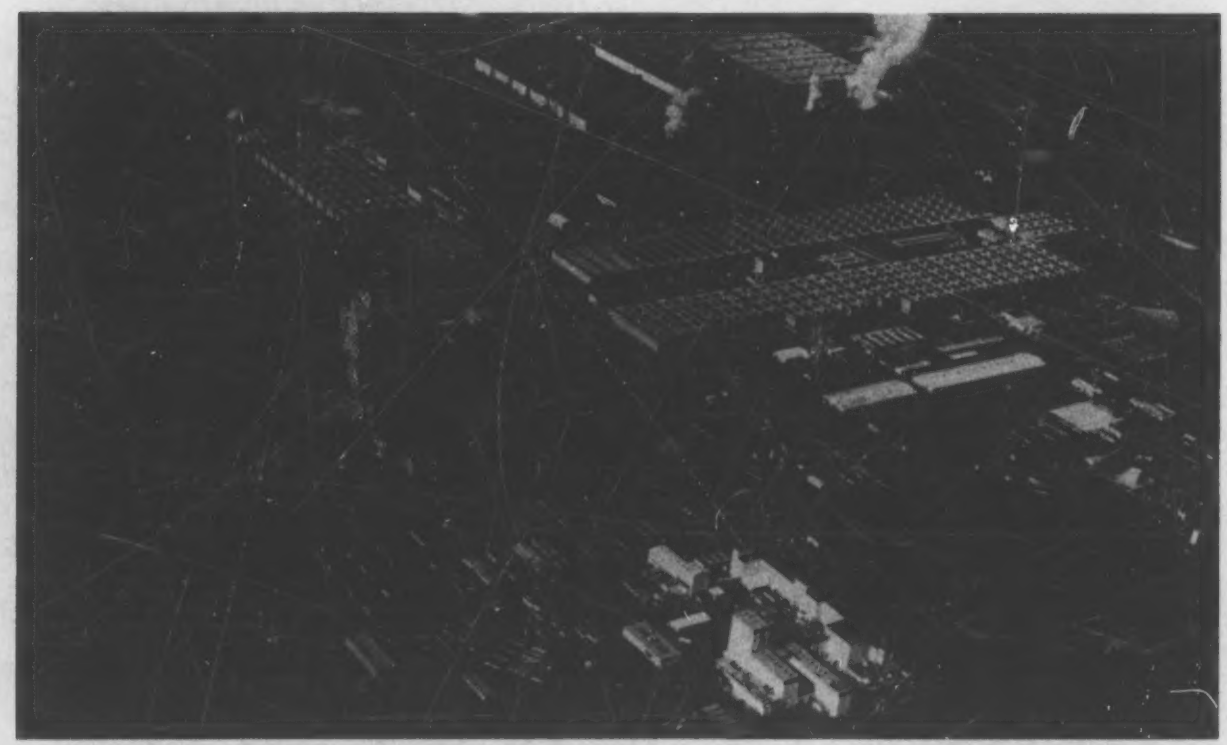

Figure 2. Aerial view of Oak Ridge GDP.

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The control valves are used to optimize gas flow between stages, and large isolation valves are used to isolate a cell from the remainder of the equipment should maintenance be required on any stage. In addition to the equipment required in the diffusion process itself, each plant has extensive feed and withdrawal gas handling systems, electrical power distribution systems and cooling towers to remove the waste heat.

Originally the Oak Ridge GDP had five process buildings. The first building constructed (code named K-25 in the Manhattan Project) has been shut down and cannibalized. It contained the smallest sized stages. The K-27 building, housing the next smallest stages, is now used only as a purge cascade. Without these two buildings in the process, the Oak Ridge GDP is no longer a complete cascade. The three remaining process buildings contain 1,540 stages.

The Paducah GDP has four operating process buildings containing 1,812 stages, including the two biggest stages DOE operates. Portsmouth is the largest plant with 4,080 operating stages. Currently Portsmouth contains the only complete cascade, and thus it is the only GDP capable of producing highly enriched uranium.

DOE integrates the use of the three GDPs according to the need for use of five different stage sizes. Because Paducah only operates two lower stage sizes, uranium is enriched there to approximately 2.0 w/o. Low enriched product then is shipped either to customers or to one of the other two plants. The Oak Ridge GDP uses three stage sizes and enriches to approximately 4.0 w/o.

Operating the plants as an integrated complex allows optimization of power and feed usage and adjustment of product and waste streams (Figure 5). The capacity of the integrated system is approximately 1 percent greater than what would be attainable by operating the three plants separately.

Capacity Expansion Programs

In the early 1970s installed nuclear capacity projections forecasted rapid increases in nuclear power use, and based on those projections the Atomic Energy Commission (AEC), DOE's predecessor, made plans to expand enrichment capacity. Congress granted approval for two expansion programs that would add 10.1 million SWUs annually to the GDPs' capacities. The two expansion programs, which increased capacity from 17.2 million to 27.3 million SWUs per year, were carried out concurrently and completed in 1982.

The Cascade Improvement Program (CIP) increased enrichment capacity by improving the efficiency of the process equipment. Based on 20 years of research and development since the original plants were built, CIP entailed the following modifications:

1. installment of new, more efficient barriers in over 3,100 diffusers;
2. reconstruction of approximately 4,000 compressors with more efficient blading and ducting;
3. improvement of diffuser configurations;
4. installment of low-loss control valves.

These modifications increased the efficiency of power usage in the plants by 32 percent, or 5.5 million SWUs annually.

The Cascade Uprating Program (CUP) added enrichment capacity by increasing power capability (and thus plant throughput) from 6.07 GWe to 7.38 GWe, or 4.6 million SWUs annually. CUP required modifications to both the process equipment and the plant auxiliary systems. Uprating the auxiliary systems allowed for additional power supplies and provided for the disposition of additional process heat. Modifications to the process

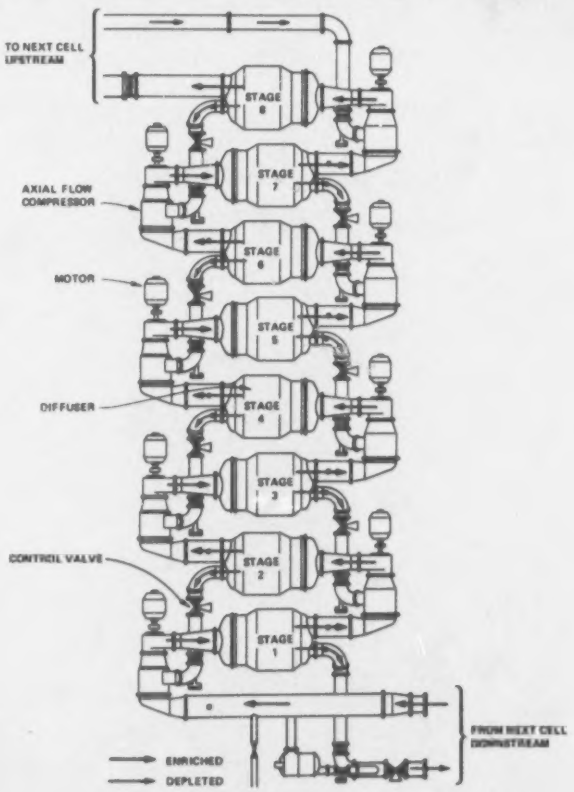

Figure 3

SCHEMATIC OF GASEOUS DIFFUSION CELL

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equipment included:

1. uprating approximately 3,800 gas compressors;
2. rebuilding over 3,000 electrical motors;
3. improving mechanical integrity of some stage components;
4. providing for increased stage heat removal at higher energy levels.

Feed and Enriched Uranium Handling

Normally a convertor assumes the responsibility for delivering acceptable UF_6 feed to the enrichment plants. Periodically DOE specifies how the feed should be divided among the three GDPs. As of November 14, 1983 Paducah accepts 45 percent, Oak Ridge takes 30 percent, and Portsmouth 25 percent.

Upon delivery cylinders are checked for air leakage and weighed. Once a cylinder is determined to be safe and its weight has been recorded, it is heated in an autoclave and two samples are taken. One sample is analyzed to determine if the feed is of acceptable quality. The second sample is held in reserve in case a dispute arises later. If the contents of the cylinder are acceptable, the cylinder is queued for feed into the enrichment process on a first-come, first-fed basis. After contents are fed an empty cylinder is weighted to determine the amount of UF_6 delivered by the customer (gross weight - empty weight). Cylinders are not actually empty at this point, but contain some residual UF_6.

One of the advantages of the gaseous diffusion process is the large number of points from which enriched product can be drawn off. Product cylinders can be filled directly from the cascade at very close to the desired enrichment level. If this were not possible, a blending operation would be required to produce the correct product assay. As is, withdrawal of product is similar to delivery of feed.

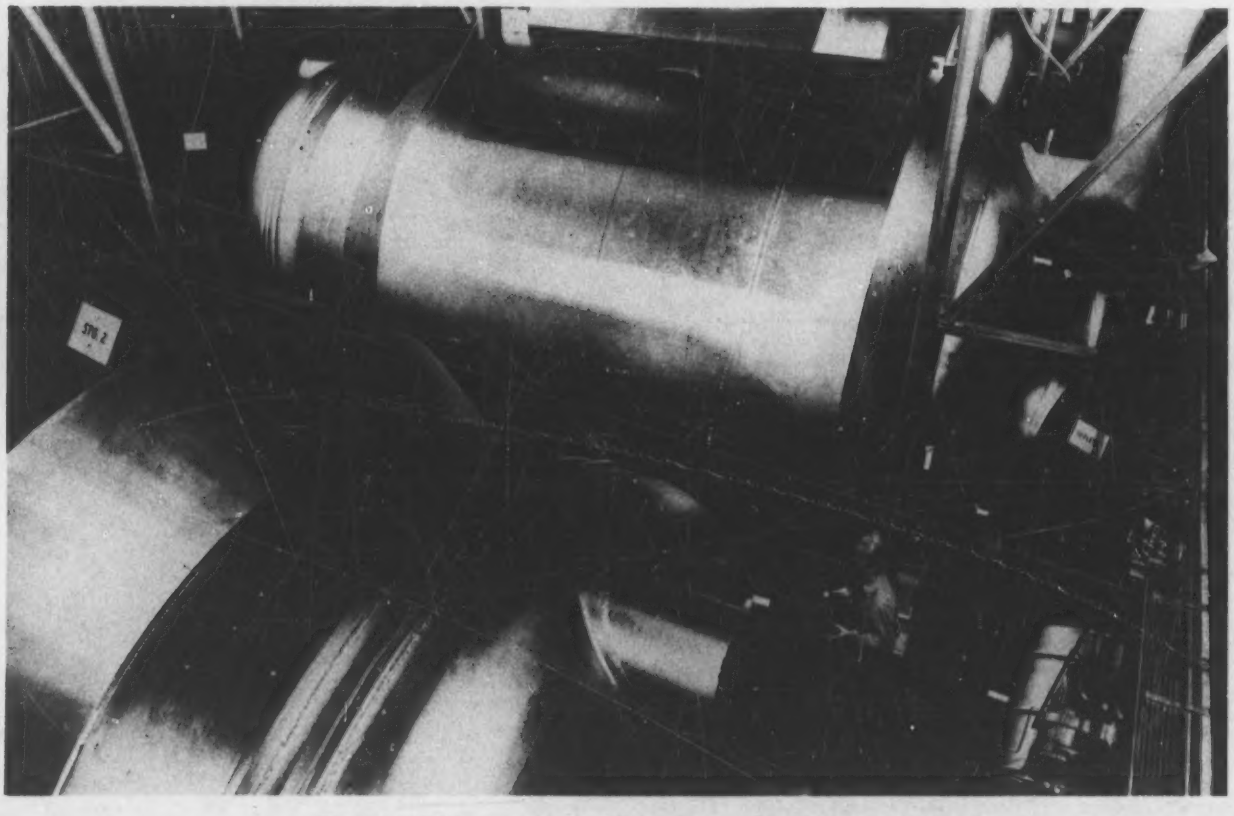

Figure 4. Diffuser vessels with corresponding stage labels.

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BASIC CONSIDERATIONS

The fabricator is usually responsible for providing product cylinders to DOE (cylinder sizes 30A or 30B) at least 30 days prior to the scheduled date of enriched product delivery. Loaded cylinders are taken to the feed receipt and product delivery facility and reheated so that two samples may be taken. Again, the first sample is for immediate analysis and the second is for retention. The final analysis of enriched product determines the amount of enrichment services and the actual amount of feed for a transaction. Product cylinders are picked up by the fabricator for shipment to the fabrication facility.

Inventory

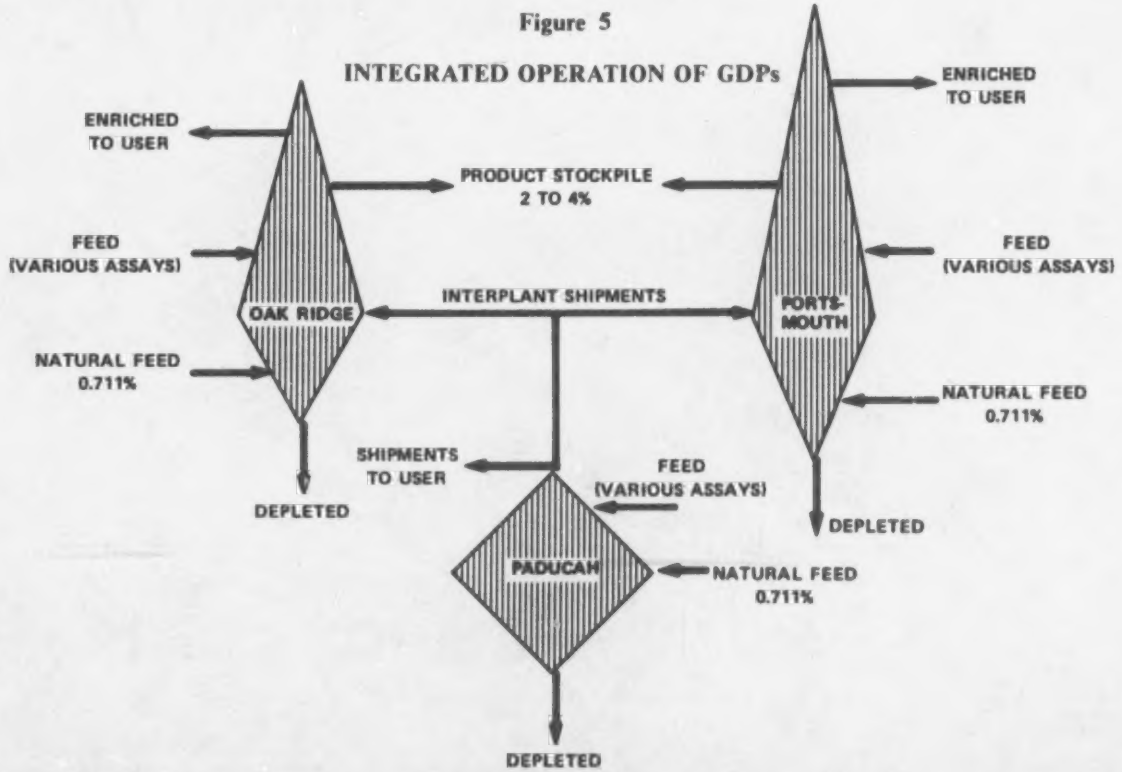
DOE has held large inventories of natural and enriched UF_6 for a number of years. At the end of FY82, DOE had in inventory the equivalent in enriched product of approximately 26 million SWUs and 47 million kgU of DOE-owned and customer-owned UF_6 feed. At that time, there were also some 260 million kgUs of depleted UF_6 in inventory. DOE plans to maintain a minimum SWU inventory of one quarter of the following year's demand. Over the next ten years, DOE projects demand to range from 20 to 30 million SWUs. Enriched inventory has been scheduled to decrease to the equivalent of approximately 9 million SWUs in FY86. However, because of market conditions and production level requirements the scheduled inventory reductions will be difficult to achieve.

Power Supply

DOE contracts with three utilities for electricity to run its enrichment facilities: Tennessee Valley Authority (TVA) for Oak Ridge and Paduca, Electric Energy Inc. (EEI) for Paducah, and Ohio Valley Electric Corp. (OVEC) for Portsmouth. Combined, the three plants are contracted to take approximately 5 GWe for 1984 operations at a cost close to $1.5 billion.

TVA will supply approximately 70 percent of the total. Recently TVA has come under attack for refusing to allow DOE to renegotiate power contracts that force DOE to pay large penalties for power not taken. DOE estimates that power not taken will exceed 50 percent of the TVA supply contract for 1984. TVA has large electricity surpluses and argues that renegotiation of the gigantic DOE contract will unfairly pass on price increases to TVA's other customers. The cost of power not taken is a major obstacle to DOE's efforts to scale back SWU production.

Figure 5



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NUCLEAR POWER IN THE UNITED KINGDOM

Introduction

In the early 1950s, the United Kingdom's Atomic Energy Authority (UKAEA) pioneered the development of gas-cooled nuclear reactors (GCRs) that use natural uranium for fuel. Several GCRs were built for commercial electricity generation through the 1960s and are still operating (Table 4), but the design became outdated as larger thermal power plants grew more common and economical. Domestic nuclear research led to the development of advanced gas-cooled reactors (AGRs) with greater capacities than earlier GCRs. Beginning in the late 1960s several AGR orders were placed, but this second generation of nuclear stations in the UK suffered numerous setbacks during the 1970s. Currently only five AGRs are operating commercially, while nine are under construction.

During the past several years alternatives to the AGR have been studied for use in a third generation of nuclear stations. Early in 1981 the Central Electricity Generating Board (CEGB) announced a plan for construction of a PWR at the Sizewell plant in Suffolk. A public inquiry into the Sizewell plan, which the government called for in mid-1981, is still underway. The proposed unit is the center of a national debate over the future of nuclear power in the UK. Moreover, the future of Britain's nuclear power program remains indefinite until the Sizewell inquiry is complete.

Development of the Gas-Cooled Reactor

In the mid-1950s the UKAEA pioneered the use of carbon dioxide gas as a coolant in the four small (50 MWe each) Calder Hall GCRs built in northern England and the four Chapel Cross reactors in Scotland. Those units were designed to use natural uranium for fuel, as enriched uranium was not yet a commercial commodity. All eight units are operated commercially today by state-owned British Nuclear Fuels Ltd. (BNFL).

Based on the early promise of the GCR, the two primary nuclear utilities in the UK, CEGB and the South of Scotland Electricity Board (SSEB), ordered a series of units for commercial use. Those units, all completed in the 1960s, were designed and constructed by consortiums of British equipment manufacturers; BNFL supplied their fuel. Two units were built at each of nine stations, known as Magnox stations (Table 4). Overall the GCRs have functioned well, and refurbishment of some has prolonged their commercial lives beyond the 25-30 years originally anticipated.

Figure 6

REACTOR SITES IN THE UK

Reactor Sites

1. Calder Hall
2. Chapel Cross
3. Berkeley
4. Bradwell
5. Hunterston
6. Trawsfynydd
7. Hinkley Point
8. Dungeness
9. Sizewell
10. Oldbury
11. Wylfa
12. Heysham
13. Hartlepool
14. Torness Point

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Advanced Gas-Cooled Reactors

The early GCRs were limited by their size. By the mid-1960s large coal-fired stations having improved thermodynamic efficiencies made new small reactors uneconomical. Nuclear Power Company Ltd. developed an AGR that used enriched uranium and could operate at a capacity exceeding 600 MWe. Together CEGB and SSEB ordered ten AGRs for five stations in the latter part of the 1960s.

A number of technical, construction and site problems arose in the execution of the AGR program, and to date only five AGRs are operational. The first order placed, for the twin 600 MWe Dungeness reactors, eventually bankrupted the company supplying the units. The Dungeness plant became the focus of difficulties associated with the AGR.

Slowdown of the 1970s

As in other parts of the industrial world, nuclear power development slowed considerably in the early 1970s for several reasons. In an attempt to revive the stalled industry, a design and construction company known as National Nuclear Corporation (NNC) was formed by the government (35 percent ownership), British Nuclear Associates (35 percent), and General Electric of the UK (30 percent). Among other things NNC studied and abandoned a pressure tube reactor, chose an LWR licensor (Westinghouse), carried out a safety study of the PWR, and declared an intention to pursue the PWR. The direction of the UK's nuclear program changed little, however, despite these gestures. In 1979 two orders for new stations were placed—both for AGRs.

Plan for Pressurized Water Reactors

The case for the PWR rested on economy, design uniformity, and the advantages stemming from participation in the mainstream of international nuclear technology. The highly successful French nuclear program, which used standardized US technology, supported this view, as did the West German convoy system.

Under the new Conservative government, the PWR project crystallized in mid-1980 into a proposed 1,110 MWe unit at Sizewell in Suffolk. CEGB applied for planning permission to the Energy Secretary in January 1981. Since the Sizewell plan involved a significant departure from established UK technology, and because of recent international experience such as that at Three Mile Island, Parliament called for a public inquiry in July 1981 to be concluded before the plan could proceed.

Sizewell Inquiry

The Sizewell inquiry was intended to give the public an opportunity to examine all of the issues surrounding nuclear power, and in particular to hear an analysis of:

1. need;
2. economics;
3. safety;
4. waste management;
5. local environmental impact.

In January 1982 the Energy Secretary announced that preliminary hearings for the inquiry would begin within the year but that the main public hearing would not begin in Suffolk until January 1983. The inquiry did commence in January 1983 but seems unlikely to be completed before the summer of 1984. The full responsibility for arguing the case rests with CEGB. Some of the points that are being debated follow.

1. CEGB's current overcapacity is 28 percent, so there appears to be no near-term need for the planned unit. Critics assert that given current scheduling Sizewell would be operational several years before any real demand had arisen. Proponents argue the benefits of phasing out older fossil fuel generation plants.

2. Advocates of nuclear power in general cite the advantages of reducing single source dependency on coal. The Sizewell unit by itself could replace only three percent of the coal-generated capacity CEGB now uses, but a comprehensive PWR program would be a practical means of electricity source diversification.

3. CEGB has argued that the PWR will produce electricity at lower costs to users, in part because of continually rising coal costs. Critics claim that if the future costs of coal are not as high as predicted, and if unforeseen delays, construction overruns and forecast errors are considered, the cost advantage of the PWR could be nullified.

4. Because of the UK's stringent plant safety requirements, the unit would be 20 percent more expensive to build than the same unit in the USA (Kansas Gas & Electric's Wolf Creek and Union Electric's Callaway units are comparable). Specific sources of cost increases would include up to 5 percent more for extra coolant injection circuits, 5 percent more to reduce radiation exposure to employees and 10 perent more to pay for the use of two turbines rather than one. CEGB's design and safety case for the PWR takes account of both US practices and the codes of practice established by the USNRC, and the procedures and approaches developed internally and by the UK Nuclear Installations Inspectorate.

5. The Sizewell site, which is owned by CEGB and has two existing GCR units, is an ideal location for a new re-

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Table 4

COMMERCIAL NUCLEAR REACTORS IN THE UNITED KINGDOM

Station/Units	MWe net Per Reactor	Type	Operating Entity	Commercial Operation	Percent Complete
Calder Hall 1,2,3,4	50	GCR	BNFL	1956	100
Chapel Cross 1,2,3,4	50	GCR	BNFL	1958	100
Berkeley 1,2	138	GCR	CEGB	1962	100
Bradwell 1,2	150	GCR	CEGB	1962	100
Hunterston A1,2	160	GCR	SSEB	1964	100
Trawsfynydd 1,2	250	GCR	CEGB	1965	100
Hinkley Point 1,2	250	GCR	CEGB	1965	100
Dungeness A1,2	275	GCR	CEGB	1965	100
Sizewell A1,2	290	GCR	CEGB	1966	100
Oldbury 1,2	300	GCR	CEGB	1968	100
Wylfa 1,2	590	GCR	CEGB	1971	100
Hinkley Point B1,2	625	AGR	CEGB	1976	100
Hunterston B1	625	AGR	SSEB	1976	100
Hunterston B2	625	AGR	SSEB	1977	100
Dungeness B1	600	AGR	CEGB	1982	100
Heysham A1,2	625	AGR	CEGB	1984	99
Hartlepool 1,2	625	AGR	CEGB	1984	99
Dungeness B2	600	AGR	CEGB	1985	99
Torness Point 1	660	AGR	SSEB	1988	45
Heysham B1	660	AGR	CEGB	1988	40
Torness Point 2	660	AGR	SSEB	1990	30
Heysham B2	660	AGR	CEGB	1990	25
Sizewell B1	1110	PWR	CEGB	1993	planned

actor. No cooling towers are needed since tunnels to the sea can be used, and no additional electricity transmission lines will be needed.

Current Nuclear Power Plans

Currently the two primary economical options for baseload generating capacity are coal and nuclear power. Approximately 80 percent of the UK's electricity is coal-generated, leaving the nation dependent on the price and availability of one fuel. The need for a better energy balance is generally recognized. Assuming the Sizewell unit is authorized, CEGB plans to begin construction on as many as seven PWRs by 1991—one each year in 1987, 1988 and 1989 and two each year in 1990 and 1991. Sizewell would be the first of a series of PWRs to reduce the nation's reliance on coal.

In the mid-1970s the UKAEA developed, designed and constructed a 250 MWe sodium-cooled fast breeder reactor at Dounreay in Scotland. The breeder reactor is viewed as the ultimate electricity source in the UK, where there is almost no indigenous uranium. Further development of the breeder is being conducted in a framework of European cooperation. Overall, there is an active and sophisticated research and development program in the UK. With internationally known component manufacturers and fuel service companies, the nuclear industry is well-developed.

Uranium Consumption and Supply

Table 5 lists Nuexco's estimate of annual U_3O_8 consumption in the UK for the period 1983-90. The consumption calculation accounts for U_3O_8 used for the

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operation of a commercial reactor at the time the uranium enters the conversion facility, so first cores are consumed approximately two years before commercial operation commences and reloads are tabulated one year before reactor loading. The steady-state consumption level of approximately 4.4 million pounds U_3O_8 in 1983-85 assumes commercial operation of the Heysham A and Hartlepool AGR stations in mid-1984 and the Dungeness B2 unit in early 1985. Increases in consumption in 1986 and 1988 account for initial cores for reactors starting up later in the decade.

Table 5

UK U_3O_8 CONSUMPTION
(millions of pounds U_3O_8)

1983	1984	1985	1986	1987	1988	1989	1990
4.4	4.4	4.4	6.8	4.5	7.2	5.0	6.4

The British Civil Uranium Procurement Directorate (BCUPD) is responsible for supplying uranium in its natural form. Its five board members include one from BNFL, one from SSEB, and three from CEGB. BCUPD's mandates are administered by the British Civil Uranium Procurement Organization (BCUPO).

Outside of reprocessed material, uranium supplies come primarily from two producers, one in Canada and Rossing in Namibia. In 1983 CEGB signed a contract with Pancontinental Mining Ltd. for 4.3 million pounds U_3O_8 from the Jabiluka deposit in Australia. Future deliveries from Jabiluka depend on permission from the Australian government, which currently is restricting new uranium mining to the Olympic Dam deposit.

The drive to diversify sources is leading BCUPO to seek equity positions in undeveloped uranium deposits. Up to now, BCUPO has participated in joint ventures only as a financing partner. It is also expanding its exploration department. A long-term CEGB goal is to have all uranium requirements supplied from BCUPO projects.

Fuel Cycle Services

BNFL, which operates the largest conversion facility in the Free World, provides for most of the upgrading, manufacture and reprocessing of fuel needed by the domestic nuclear program. During the 1970s, BNFL developed a number of advanced techniques in fuel element manufacture. It also joined UCN of the Netherlands and Uranit of West Germany in the development of Urenco, the centrifuge enrichment consortium. Urenco currently has the capacity to produce 1.1 million SWUs per year. In addition to receiving enrichment services from Urenco, CEGB has an enrichment contract with Techsnabexport of the USSR.

Conclusion

The UK's nuclear power program is at a turning point with the Sizewell inquiry, which is focused on a single unit but has wide implications. Although the present government has tried to remove itself from the inquiry, ultimately the Energy Secretary reserves the authority to approve the unit and the Health and Safety Executive decides whether to grant a construction and operating license. Future uranium needs will be determined by the performance of the nine AGRs that are under construction and by the success of the PWR plan. BCUPO is enacting a comprehensive program to diversify uranium supply sources and to increase the UK's participation in international uranium projects.

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JAPAN'S NUCLEAR POWER INDUSTRY INFRASTRUCTURE

Introduction

Behind Japan's rapidly growing commercial nuclear power industry are well-organized electric utilities and a strong national industrial base. This article is an overview of Japan's utility industry, its approach to nuclear power, and its main industrial partners involved in the production of nuclear-related hardware and services.

Electric Utilities

Prior to World War Two the Japanese government consolidated several hundred small utility enterprises and established a nationwide wholesale utility, the Japan Electric Power and Transmission Company (JEPTC). During the war, nine regional monopolies known as electric power distribution companies were organized to distribute electricity to users. Postwar legislation forced these nine regional monopolies to acquire their present form as integrated shareholder companies (Table 6). Together these nine companies distribute power over most of the country (Figure 7), and their combined generation capacity accounts for approximately 75 percent of Japan's total.

In Table 6 four groups are listed in addition to the nine regional electric power companies.

1. The Electric Power Development Corporation (EPDC) has been compared to the Tennessee Valley Authority (TVA) in the USA. The government organized EPDC in 1952 to develop hydroelectric projects and to build coal-fired generation facilities that would stimulate the domestic coal industry. EPDC sells electricity to the regional private utilities.

2. Japan Atomic Power Company (JAPC) was organized in 1957 primarily by the nine regional utilities and EPDC for the purpose of pioneering nuclear plant concepts. JAPC also sells electricity to the regional utilities.

3. Other utilities include more than 50 smaller, primarily public enterprises that operate hydroelectric facilities and various joint venture thermal power plants. Most of them wholesale their electricity to the nine regional utilities. Okinawa Electric Power Company, which serves the island of Okinawa, is counted in this category.

4. Industry-owned electrical generation facilities are associated with the operation of industrial facilities such as refineries, steel mills, etc.

As of October 31, 1983, total generation capacity of the nine private utilities, EPDC, JAPC and other utilities totaled 142.1 GWe compared to the 135.6 GWe noted in

Figure 7

REGIONAL COVERAGE OF NINE UTILITIES

Table 6. With 24 operational plants, nuclear generating capacity currently amounts to 17.2 GWe. (Report 179 of July 1983 provides an overview of Japan's nuclear generating capacity and uranium supply demand balance.)

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Development of Nuclear-Related Industries

In 1955 the government established the Japan Atomic Energy Commission to oversee the promotion and development of nuclear power. Utilities responded with the creation of JAPC and of nuclear departments internally. The first plans for commercial development came from the two largest utilities, Tokyo Electric Power Company (TEPCO) and Kansai Electric Power Company (Kansai), other utilities followed with later schedules.

Concurrently, Japanese manufacturing concerns organized into five major nuclear groups, based to a degree on historical industrial and financial relations. Most groups consisted of at least one heavy equipment maker, one civil engineering company and related support companies that together would provide the comprehensive engineering and manufacturing expertise needed to undertake a complete nuclear power plant project. Table 6 lists the five industrial groups and the major participants in each one.

Of the five industrial groups, three had non-nuclear electric generation equipment licensing relations with US contractors involved in the then developing US market. Based on those relations, Toshiba of the NAIG group and Hitachi of the TAPIC group entered into agreements in the mid-1960s with General Electric Company (GE) of the USA for a BWR systems license, for nuclear turbine-generator manufacture, and for a license to manufacture nuclear fuel. The fuel agreement led to a joint venture between GE and the Japanese partners to manufacture fuel in Japan. Westinghouse of the USA concurrently concluded similar license agreements with the Mitsubishi group for PWR technology. Those agreements provided the technical basis for the subsequent development of Japan's own LWR technology.

Japanese utilities had initiated programs to construct reactors prior to the license agreements with GE and Westinghouse. Those programs were coordinated efforts designed to give potential licensees and related companies actual experience in hardware manufacture, systems, fuel, and plant construction. The country's first operational reactor was a small 12.5 MWe demonstration BWR supplied by GE and operated in 1963 by the Japan Atomic Energy Research Institute. Toshiba and Hitachi were subcontractors, and Japanese utility personnel participated in the operation of the unit. By 1971, four units were operating commercially, as illustrated in Table 8.

Table 6

PRIMARY SUPPLIERS OF JAPANESE ELECTRICITY[1]

Utility	Customers (millions)	Employees (thousands)	Operating Plants	Capacity (GWe net)
Hokkaido EPC[2]	2.7	6.3	76	3.6
Tohoku EPC	5.6	12.6	221	7.9
Tokyo EPC	18.2	40.1	191	32.9
Chubu EPC	7.3	19.2	185	17.7
Hokuriku EPC	1.5	5.6	118	3.6
Kansai EPC	9.4	24.1	154	23.4
Chugoku EPC	4.1	11.8	108	7.8
Shikoku EPC	2.2	6.6	65	4.8
Kyushu EPC	6.0	14.6	188	10.0
TOTAL Nine Utilities	56.9	140.9	1,306	111.6
Electric Power Development Co.		3.5	54	8.8
Japan Atomic Power Co.		1.1	3	1.6
Other Electric Utilities			285	13.6
TOTAL Other Utilities			342	24.0
Industry-Owned Electricity Generation			781	14.6
TOTAL JAPAN			3,429	150.2

[1]Source: Electrical Industry Survey Institute, 1982.
[2]EPC = Electric Power Company.

Construction of those four reactors provided Japanese utilities, manufacturers and civil companies with experience upon which to base their future programs. The projects also solidified a network of relations in the nuclear industry. Although General Electric of the UK, Westinghouse, and GE of the USA participated in these initial plants as prime contractors, approximately 65 percent of plant hardware was fabricated by the Japanese subcontractors. The English GCR has not had a subsequent role in Japan's nuclear power program.

Since 1971 20 reactors have been placed in operation by Japanese utilities. Most of those units have been supplied by the Japanese licensees of the US LWR makers. Aside from some minor importation of components and services, reactor supply has become essentially 100 percent domestic.

Reactor Construction Program

Of the nine regional utilities, all except two, Hokkaido EPC and Hokuriku EPC, have successfully implemented nuclear programs. Presently Hokkaido is seeking licenses for its first two units. Several generalizations characterize the programs of all the nuclear utilities.

1. Each utility has relied solely on one reactor type, either BWR or PWR, for its nuclear program. TEPCO, for example, has seven BWRs operating and six under construction. Kansai has seven PWRs operating, and four under construction or licensing review. Only JAPC, in its role as a new-concept pioneer, is building a PWR in addition to its operating GCR and BWRs. By staying with a single reactor type, the utilities have at times suffered from generic problems common to all units. They have, however, developed a high degree of reliability in their plants and competence in their organizations.

While Japanese BWR and PWR designs are based fundamentally on technology acquired from the US licensors, some modifications have been requisite. For example, plant configurations must accommodate Japan's unique seismic conditions. Utilities' desires for better maintenance access and the government's stringent limits on worker radiation exposure levels have also been accommodated.

2. One of the three main domestic reactor suppliers, Toshiba (BWR), Hitachi (BWR), and Mitsubishi (PWR), with support from companies in its respective industrial group, supplies on a turnkey basis virtually all nuclear and turbine generator hardware and systems for a given plant. Supply includes comprehensive architect-engineering services and licensing support, installation of equipment, related piping and electrical work, and extensive warranty and retrofit service. Exceptions to this rule include:

a. Some BWRs have been built with nuclear steam supply systems supplied by Toshiba, while the turbine generators were supplied by Hitachi, and vice versa.

b. US suppliers and architect-engineering firms have participated when new system designs have been introduced, or when new concepts related to licensing have been implemented. Japanese reactor makers maintain license and technical exchange agreements with overseas engineering companies; both Hitachi and MHI, for example, have agreements with Bechtel of the USA.

c. Supply and installation of waste treatment facilities has been conducted by companies not affiliated with the Japanese suppliers.

Table 7

JAPANESE NUCLEAR INDUSTRIAL GROUPS

Group Name	Hardware/Systems Supply	Civil Engineering	Companies in Group
Mitsubishi	Mitsubishi Heavy Industries Mitsubishi Elec.	Ohbayashi-Gumi Taisei Constr.	27
Tokyo Atomic (TAPIC)	Hitachi Ltd. Babcock-Hitachi	Kajima Corp.	22
Nippon Atomic (NAIG)	Toshiba Corp. Ishikawajima Harima Heavy Industries	Takenaka Komuten Shimuzu Constr.	33
Sumitomo Atomic	Sumitomo Heavy Industries Sumitomo Metals Sumitomo Atomic Power Industries		38
First Atomic (FAPIG)	Fuji Elec. Kawasaki Heavy Industries	Shimuzu Constr.	22

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Table 8

JAPAN'S FIRST FOUR COMMERCIAL REACTORS

Unit and Owner	MWe	Type	Supplier	Japanese Subcontractor	Commercial Operation
Tokai 1 (JAPC)	166	GCR	GE (UK)	FAPIG	1966
Tsuruga 1 (JAPC)	357	BWR	GE (USA)	Toshiba Hitachi	1970
Mihama 1 (Kansai EPC)	340	PWR	Westinghouse	Mitsubishi	1970
Fukushima 1 (Tokyo EPC)	460	BWR	GE (USA)	Toshiba Hitachi	1971

3. Generally the utilities contract civil work—building design and construction of facilities—to one of the major Japanese construction companies (Kajima, Shimizu, Taisei, Ohbayashi-Gumi, Takenaka). For earlier plants such contracts were arranged on the basis of the civil company's relationship to the maker's group. In recent years there has been some diversity and crossing of group relations, and several joint ventures have occurred among the five main constructors.

The construction companies perform their scope of work on a turnkey basis. Reactor suppliers undertake to coordinate hardware/system licensing and design processes with the construction companies. Utilities maintain responsibility for overall project management.

4. Contracts with nuclear makers and builders normally are negotiated with sole sources for lump sums, precluding competitive bidding. While this contracting method is often criticized outside Japan, contractors in general have performed on schedule and within budget. Final plant costs in Japan are competitive with costs in other countries, and contruction time is far shorter.

Fuel Fabrication

Utilities arrange for fuel fabrication with the three reactor makers—Toshiba, Hitachi and Mitsubishi. Actual fabrication of BWR fuel is performed by Japan Nuclear Fuel (JNF), a joint venture established under an early fuel license agreement between Hitachi/Toshiba and GE. Mitsubishi Nuclear Fuel (MNF) fabricates PWR fuel, in accordance with Mitsubishi's early agreement with Westinghouse. Table 9 lists the fuel fabrication companies and their capacities. Nuclear Fuel Industries (NFI) was organized by members of the Sumitomo and FAPIG groups to fabricate BWR, PWR and test reactor plate fuel.

Conclusion

The current Japanese nuclear generation industry is mature and almost entirely self-sufficient. Of the five industrial groups initially organized to develop Japan's nuclear program, the dominant role has gone to those represented by the three leading reactor makers, Toshiba, Hitachi and Mitsubishi Heavy Industries (MHI). These three organizations are also participants in the national programs sponsored by the Japanese government for development of a Fast Breeder Reactor and of fushion technology. While it still relies on overseas suppliers for fuel cycle services, Japan is also in the process of developing its own conversion, enrichment and reprocessing capabilities. By the turn of the century, uranium supply may be the only element of the commercial nuclear power program for which the Japanese will be dependent on foreign supply.

Table 9

JAPANESE NUCLEAR FUEL COMPANIES

Company	Ownership	Fuel Type	Capacity (tons/yr)	Planned Capacity
JNF	Toshiba Hitachi GE	BWR	490	750 by 1985
MNF	Mitsubishi Metals MHI Westinghouse	PWR	420	420
NFI	Furukawa Elec. Sumitomo Elec.	BWR PWR	40 85	100 by 1984 265 by 1984

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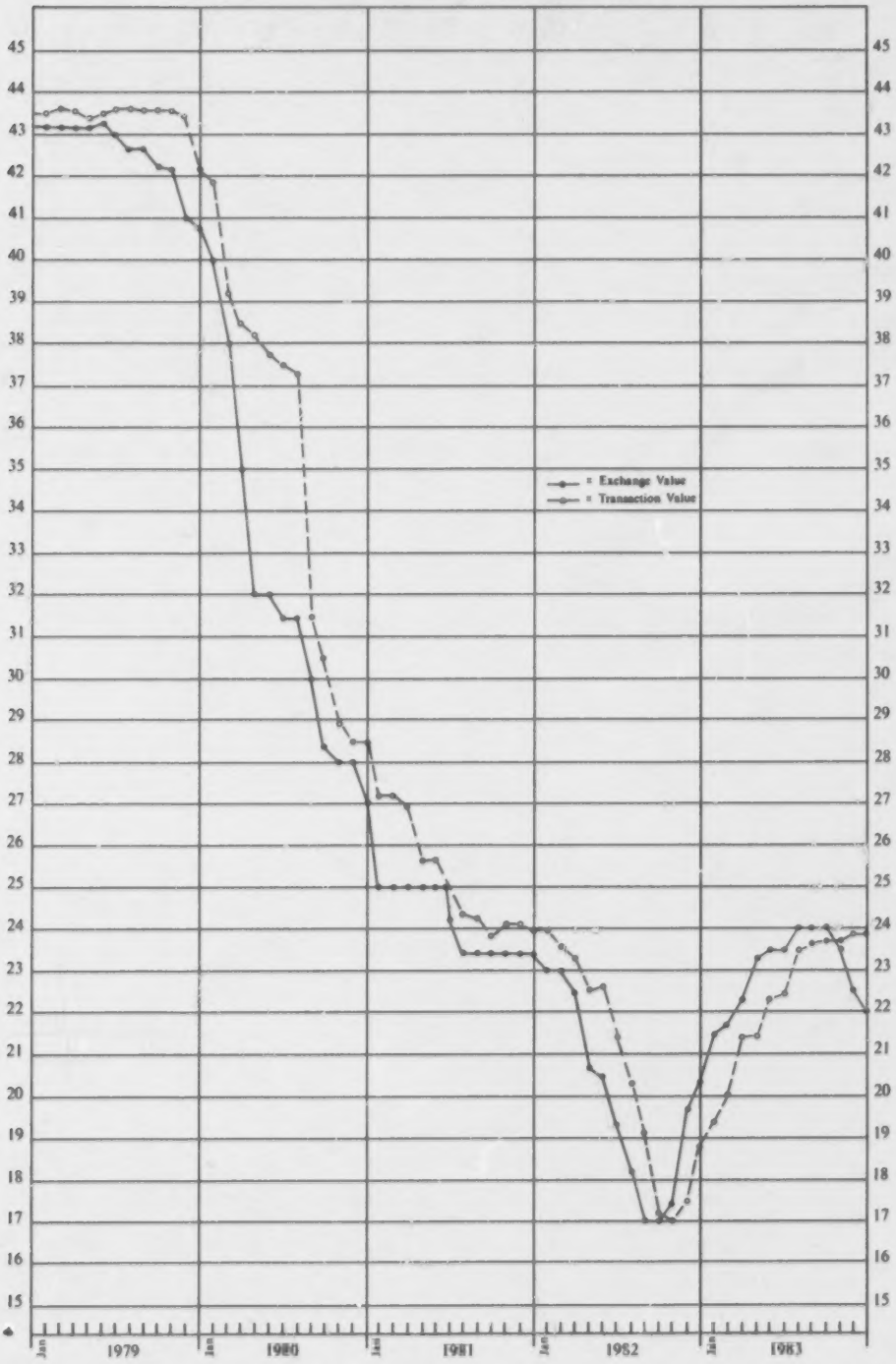
EXCHANGE AND TRANSACTION VALUES
SINCE JANUARY 1979
Determined as of the last day of the month indicated



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HISTORICAL MARKET DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	22.50	22.00

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	23.85	23.85

HISTORICAL CONVERSION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U as UF_6)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	0.60	0.60

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AUSTRALIA

	Price Index of Materials Used in Manufacturing Industry—All Groups[1] (1969=100)	Award Rates of Pay Indexes Australia—Adult Males In Mining Wage Earners, Weekly Rates[2] (1976=100)
1972 Avg.	105.6	71.3
1973 Avg.	124.4	79.0
1974 Avg.	141.9	108.1
1975 Avg.	150.4	132.6
1976 Avg.	168.4	160.9
1977 Avg.	192.0	179.0
1978 Avg.[3] [4]	198.5	190.0
1979 Avg.	248.8	127.9
1980 Avg.	321.8	140.8
1981 Avg.	355.3	154.1
1982 Avg.[5]	368.6	174.9
Sep 1982	375.3	178.4
Oct 1982	378.5	178.4
Nov 1982	375.9	178.5
Dec 1982	374.9	179.5
Jan 1983	385.7	179.6
Feb 1983	387.5	179.5
Mar 1983	397.4	179.4
Apr 1983	407.3	179.7
May 1983	414.8	179.8
Jun 1983	415.6	179.9
Jul 1983	408.4	179.5
Aug 1983	403.1R	179.5
Sep 1983	403.1P	179.4
Oct 1983	—	186.4P

P = Preliminary R = Revised since last month

[1]Australian Bureau of Statistics, Canberra: "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0).
[2]Australian Bureau of Statistics, Canberra: "Award Rates of Pay Indexes, Australia" (Catalogue No. 6312.0). Figures for the latest fourteen months shown are subject to revision.
[3]Monthly data for 1970-78 appear on pages 4.7 and 4.8 of Report 138.
[4]Annual averages prior to 1979 reflect index base no longer in use.
[5]Monthly data for 1979-82 appear on page 35 of Report 184.

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GOVERNMENT STATISTICS

CANADA

	Industry Selling Price Index: Manufacturing[1] (1971=100)	Wage-earner Data: Average Hourly Earnings (C$)[2] [3]				
		Metal Mining, including Milling[4] (SIC 050-099)	Primary Metal Industries Non-ferrous[5] (SIC 296)	(SIC 296-298)	(SIC 298)	Chemicals and Chemical Products[6] (SIC 370-379)
1979 Avg.[7]	217.9	9.66	—	7.35	—	7.67
1980 Avg.	247.2	10.80	—	8.05	—	8.50
1981 Avg.	288.7	12.23	—	9.03	—	9.53
1982 Avg.[8]	288.8	13.92	—	9.98	—	10.63
Sep 1982	292.4	14.01	—	10.18	—	10.73
Oct 1982	292.1	13.89	—	10.18	—	10.86
Nov 1982	291.3	14.28	—	10.43	—	10.90
Dec 1982	292.3	14.32	—	10.55	—	11.06
Jan 1983	292.7	14.35	—	10.72	—	11.06
Feb 1983	293.5	14.28	—	10.74	—	11.06
Mar 1983	295.2	14.48	—	10.93	—	11.21
Apr 1983	297.1	14.13	11.57	—	10.10	11.02
May 1983	298.5	14.10	11.39	—	9.82	10.97
Jun 1983	299.3	14.07	11.33	—	9.84	11.05
Jul 1983	300.4	13.93	11.70	—	9.83	11.04
Aug 1983	301.2	13.89	11.82	—	10.08	11.19
Sep 1983	309.9R	14.41R	11.99R	—	10.32R	11.19R
Oct 1983	301.4R	14.37P	11.72P	—	10.60P	11.37P
Nov 1983	301.5P	—	—	—	—	—

P = Preliminary R = Revised since last month

[1]Statistics Canada, Prices Division, Ottawa: "Industry Price Indexes" (Catalogue 62-011). Indexes for the most recent six months shown are subject to revision.

[2]Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa: "Employment, Earnings and Hours" (Catalogue 72-002).

[3]Beginning with the April 1983 figure, Wage Earner Data are based on a census of all companies employing 200 or more wage earners, *plus* a random survey of companies employing fewer than 200 wage earners. Prior to April 1983 only companies employing fewer than 200 wage earners are included in the Wage Earner Data.

[4]The wage earner series in Nuexco reports prior to March 1983 was "Metals" (SIC 050-059).

[5]Beginning with the April 1983 figure, Primary Metal Industries, non-ferrous is split into SIC 296 and SIC 298.

[6]Chemical and Chemical Products prior to April 1983 was SIC 370-379. The new series is from a new survey which includes all companies and is based on a 1970 classification. The old survey only included companies of 20 employees or more.

[7]Monthly ISPI for 1977 and 1978 appear on page 4.10 of Report 138, and monthly wage-earner data for 1973-78 appear on page 4.11 of Report 138.

[8]Monthly data for 1979-1982 appear on page 37 of Report 184.

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REPUBLIC OF SOUTH AFRICA

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100)	Producer Price Index All Groups[4] (1975=100)[5]	Total Employment in Mining and Quarrying (Code 35)[6]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[5]
1972 Avg.	8.79	113.3	63.9	623,067	443,933
1973 Avg.	10.51	124.1	72.3	684,743	572,133
1974 Avg.	13.18	138.5	85.3	674,140	761,596
1975 Avg.	16.71	157.2	100.0	639,473	1,003,617
1976 Avg.	19.30	174.7	115.1	671,240	1,212,983
1977 Avg.	23.87	194.4	130.0	712,006	1,420,670
1978 Avg.	27.14	137.2	142.7	664,571	1,537,169
1979 Avg.[6]	30.18	155.3	164.5	692,209	1,830,632
1980 Avg.[7]	35.53	176.7	192.1	714,379	2,279,615
1981 Avg.	41.89	206.5	218.3	728,506	2,820,505
1982 Avg.[8]	47.25	233.5	248.7	707,552	3,246,071
Jun 1982	45.77	232.1	246.7	707,552	261,361
Jul 1982	—	234.1	249.4	702,141	283,248
Aug 1982	—	236.8	253.4	705,562	276,730
Sep 1982	48.04	241.0	255.0	704,344	282,782
Oct 1982	—	243.9	260.1	701,316	285,328
Nov 1982	—	245.4	262.5	707,966	287,699
Dec 1982	49.62	246.2	263.0	683,982	288,019
Jan 1983	—	249.0	264.9	688,030	289,075
Feb 1983	—	253.1	267.4	697,089	281,413
Mar 1983	50.35	255.9	269.1	695,976	290,586
Apr 1983	—	257.8	270.9	697,158	286,708
May 1983	—	259.7	274.1	701,712	295,701
Jun 1983	50.51	260.8	273.1	706,933	300,177
Jul 1983	—	262.5	273.7	704,202	314,566
Aug 1983	—	265.6	278.9	698,984	311,789
Sep 1983	52.92	267.3	279.4	—	—
Oct 1983	—	270.0	281.0	—	—
Nov 1983	—	271.4	—	—	—

[1]Chamber of Mines of South Africa, Johannesburg; "Analysis of Working Results," published quarterly. The tonnage-weight index of average working costs per metric ton of gold ore milled for 1983 follows. (Base: March quarter 1982 = 100). See page 16 of Report 178 for the description and calculation of index, and page 24 of Report 178 for figures for 1982.

1983:	January-March	111.2
	April-June	111.9
	July-September	117.4

[2]Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Price Index for Urban Areas."
[3]For annual averages prior to 1978, April 1970 = 100.
[4]Previously known as the WHOLESALE PRICE INDEX, now the PRODUCER PRICE INDEX. The computation remains the same.
[5]Bulletin of Statistics, Department of Statistics, Pretoria.
[6]Historical data for the Average Declared Working Costs and Consumer Price Index 1970-1979 appear on page 4.9 of Report 140.
[7]Monthly data for Codes 35 and 40, 1977-1980, appear on page 28 of Report 157.
[8]Monthly data for 1979-82 appear on page 39 of Report 184.

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GOVERNMENT STATISTICS

UNITED STATES

	Producer Price Index[1] Industrial Commodities (1967=100)	Producer Price Index[1] All Commodities (1967=100)	Consumer Price Index[2] (1967=100)	GNP Implicit Price Deflator[3] (1972=100)	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4] Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1972 Avg.	117.9	119.1	125.3	100.00	4.56	4.59	4.26	3.71
1973 Avg.	125.9	134.7	133.1	105.75	4.84	4.98	4.51	3.91
1974 Avg.	153.8	160.1	147.7	115.08	5.44	5.63	4.88	4.21
1975 Avg.	171.5	174.9	161.2	125.79	6.13	6.24	5.39	4.64
1976 Avg.	182.4	183.0	170.5	132.34	6.76	6.87	5.91	4.96
1977 Avg.	195.1	194.2	181.5	140.05	7.28	7.67	6.43	5.39
1978 Avg.[5]	209.4	209.3	195.4	150.42	8.23	8.56	7.02	5.82
1979 Avg.	236.5	235.6	217.4	163.42	9.27	9.50	7.60	6.32
1980 Avg.	274.8	268.8	246.8	178.64	10.26	10.63	8.30	6.94
1981 Avg.	304.1	293.4	272.4	195.51	11.55	11.98	9.12	7.62
1982 Avg.[6]	312.3	299.3	289.1	207.15	12.33	12.94	9.96	8.21
Nov 1982	315.0	300.3	293.6	—	12.53	13.22	10.26	8.45
Dec 1982	315.2	300.7	292.4	210.00	12.53	13.05	10.32	8.51
Jan 1983	313.9	299.9	293.1	—	12.63	13.33	10.34	8.53
Feb 1983	313.9	300.9	293.2	—	12.66	13.29	10.41	8.56
Mar 1983	313.5	300.6	293.4	212.83	12.48	13.35	10.39	8.60
Apr 1983	312.4	300.6	295.5	—	12.67	13.34	10.43	8.60
May 1983	313.6	301.5	297.1	—	12.55	13.62	10.50	8.60
Jun 1983	315.3	302.4	298.1	214.55R	12.66	13.38	10.52	8.63
Jul 1983	316.5R	303.2	299.3	—	12.68	13.56	10.58	8.69
Aug 1983	317.5	304.9	300.3	—	12.63	13.46	10.61	8.64
Sep 1983	317.2	305.3	301.8	216.44R	12.71	13.47	10.69	8.75
Oct 1983	318.7	306.3	302.6	—	12.77	13.56R	10.78	8.73
Nov 1983	318.3P	305.6P	303.1P	—	—	—	10.85P	8.77P

P = Preliminary R = Revised since last month

[1]US Bureau of Labor Statistics, Washington, D.C.: "Producer Prices and Price Indexes," (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

[2]US Bureau of Labor Statistics, Washington, D.C.: Consumer Price Index for All Urban Consumers, US City Average, All Items.

[3]US Department of Commerce, Washington, D.C.: Bureau of Economic Analysis, National Income and Wealth Division: "Survey of Current Business." The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

[4]US Bureau of Labor Statistics, Washington, D.C.: "Employment and Earnings." 2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. Data for 1977-1978 are adjusted to the March 1979 benchmark. Data for January 1979 and beyond are adjusted to the March 1980 benchmark.

[5]Monthly data 1970-1978 for Producer Price Index-Industrial Commodities, Consumer Price Index, and Employment and Earnings SIC codes 10, 333, and 28, and quarterly data for GNP Implicit Price Deflator appear on pages 4.6-4.8 of Report 139.
Monthly data 1977-1978 for Employment and Earnings SIC Codes 10, 333, and 28 appear on page 33 of Report 147.
Monthly data 1970-1978 for Employment and Earnings SIC Code 36 appear on page 23 of Report 154.
Monthly data 1977-1980 for Producer Price Index-All Commodities, appear on page 21 of Nuexco Report 158.

[6]Monthly data 1979-1982 for all listed indices appear on page 41 of Report 184.

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REPRESENTATIVES AND CONSULTANTS

AUSTRALIA

Peter Stork
Oratom Consulting*
5 Gould Ave.
St. Ives
NSW 2075, Australia
Telephone: (61-2) 449-6783
Telex: 73303 (ORATOM AA)

JAPAN

Kazy Yokota
Japan Tech Services*
Ohkura Building (3F)
1-4-10 Shiba Daimon
Minato-ku, Tokyo, Japan
Telephone: (81-3) 431-6031, 6025
Telex: 242-5060 (JATECH J)

SOUTH AFRICA

Chris I. Von Christierson
Southern Prospecting (Pty) Limited*
P.O. Box 61409
Marshalltown 2107
Republic of South Africa
Telephone: (27-11) 838-1868
Telex: 8-9878 SA

TAIWAN

Edward Bee
Bee & Liang Company, Ltd.*
14 FL. Universal Business Center
NO. 663, Tun Hwa South Road
P.O. Box 1396
Taipei, Taiwan R.O.C.
Telephone: (886-2) 704-9630
TWX: 785-11570 (BEELIANG)

UNITED STATES

Harold C. Lindberg*
83-A Hardee Lane
Whispering Pines, N.C. 28327
Telephone: (919) 949-3622

Joe L. Hixon*
302 Lombardy
Sugarland, Texas 77478
Telephone: (713) 494-3802

W. Hardy Prentice*
11644 Harborview Drive
Cleveland, Ohio 44102
Telephone: (216) 631-2350

SPECIAL CONSULTANTS

Karl Cohen
Palo Alto, California

James C.C. Stewart
England

Claus C. Thiesen
Kirkland, Washington

W. Bryan Webster
San Jose, California

T.C. Wu
Hong Kong

*Independent contractors representing Nuexco

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